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makes Corvair**

**150
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Hot**



50th ANNIVERSARY
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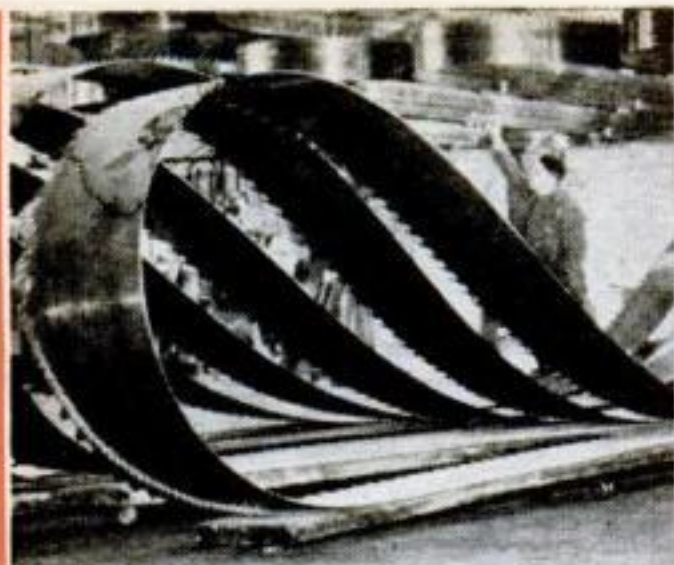
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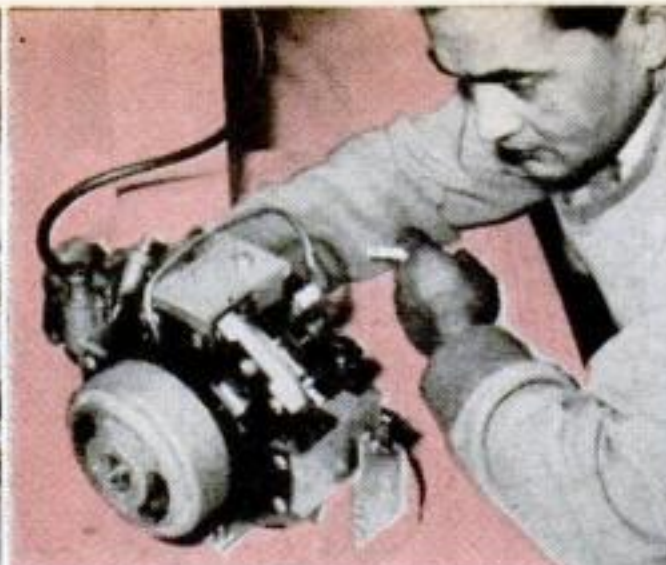
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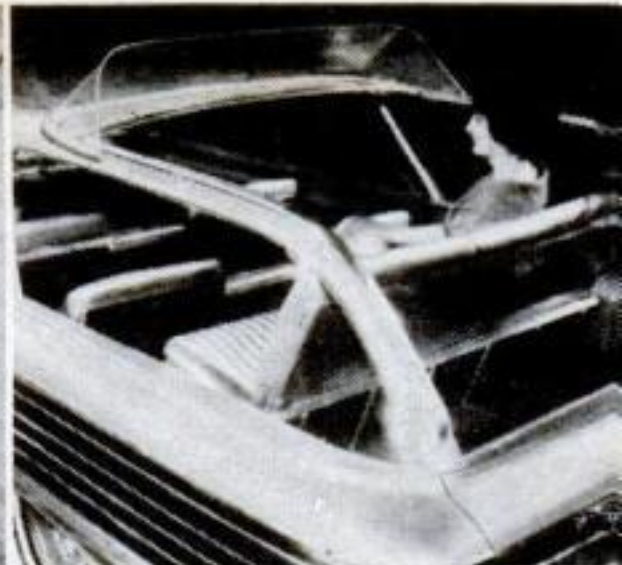
Hi-Miler—T.M. The Goodyear Tire & Rubber Company, Akron, Ohio



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Box engine: *Hinges take the place of pistons. P. 116*



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Popular Science ®

Popular Science

April, 1962

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Thinking ahead to vacation time? See next month's big special section to get off to a running start.

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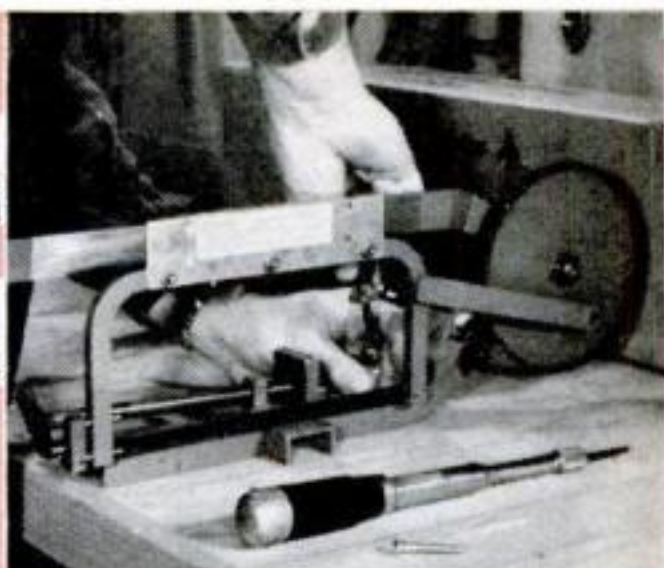
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Woods: Color pictures show you how to tell 'em apart. P. 155



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Mechanics and Handicraft ®

Monthly®

90th ANNIVERSARY YEAR

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PS Readers



PS Picture Gallery

IS THE judo picture on the February cover a cutout? Can it be real? Somehow, the pants of these two guys just don't hang right. And the placid expression on the visible face doesn't quite look like that of a man who, with a mighty fling of his right foot, has just sent a guy flying through the air with the greatest of ease.

If you turn the magazine so that the feet are next to you, it looks as though all four feet are on the rug and the men are gently tugging at the armpits of each other's shirts, poised there while the photographer gets his lighting fixed. And the pants pretty well cooperate with gravity. How did Mr. Morris take the picture, and how did your layout men put it together?

GEORGE C. HARDIN, Lansdowne, Pa.

The picture is not faked. Four heavy judo mats were covered with red canvas (\$75 worth). Test shots were taken with a white background and a red background, and we settled for red. Finally, two judo men (one a "black belt") came to the studio. Thirty-two throws were made and the best action shot selected. Exposure was made by two Ascor strobes of 800 watt/seconds each.

The black-and-white print above plainly shows the wall line where mat and background meet, and where the red background was not high enough, requiring us to make a color print and fill in the top of the transparency that was used on the cover.

... EVEN without the explanation [Jan., p. 73], I would assume that the January cover picture was a bit of trick photography.

TALK BACK

The car, which is "apparently charging across the landscape," has no driver.

R. D. BARTLEBAUGH, Pennsauken, N.J.

The driver, in shadow against the dark background and blurred by double exposure, is there. A driver was necessary to put the car in reverse and guide it as it sped backward.

They Want More

"How to Handle a Slide Rule" [Jan., p. 94] was a nice article. But why did you show us how to use only one scale when there are so many others? How about another go-round on the uses of other scales?

MICHAEL SCHUDROWITZ, Milwaukee.

... AFTER I read Ted Vincent's article, I pulled out of a drawer a rather expensive slide rule that I purchased while overseas, thinking some day I'd learn to use it. That was some 12 years ago, but I never got around to laying out the cost of an instruction book.



With your article before me, I worked out the problems you gave and enjoyed the entire evening. How about some bonus booklets giving more on this subject?

V. C. ESTES JR., Bristow, Okla.

Three Engines Out

LIKE Mr. Akers ["PS Readers Talk Back," Jan., p. 22], I'd like to reminisce, too, about that great ship—the B-36. I was a member of the first crew that brought in a B-36 with three engines out on the left wing.

This was in July, 1949, when I was a student flight engineer on aircraft No. 2036. Shortly after reaching cruise altitude, there was a fire-warning signal for No. 3 engine on my panel. Before I could feather No. 3, warning lights flashed for engines 1 and 2 and attempts to feather these failed.

As the aircraft commander started his let-

CONTINUED

BIG JOB BOOM FORECAST!

Can You Get Ready in Time?

Right now job opportunities are tight all along the line. Economists now predict a period of mild ups and downs. Look for the "big break" to come in the next three years, they say. That's when good jobs will open up as never before. And men who are preparing themselves *now* will ride the crest of the boom.

DARK OUTLOOK FOR UNSKILLED WORKERS

Those with little or no training will find the going tough. Fewer openings. More competition for existing jobs. The tide is against the unskilled worker. It's getting stronger. Nor will the boom help. The new opportunities will go first to the skilled, next to the semi-skilled.

BIGGEST DEMAND IN THESE FIELDS

What's ahead? According to the best estimates, here are the industries due for the sharpest employment rise: Heavy transportation equipment. Mechanical, electrical, chemical, aeronautical and highway engineering. Industrial electronics.

All metals. Business services. Natural gas and oil. Paper products. On the other end of the scale, employment may lag in agriculture and leather. Check the trends in *your* field. Are you prepared to switch, if necessary?

GETTING YOURSELF READY—NOW

All the experts agree: Education, skill, specialized training will net the greatest rewards in the coming boom. The time you spend improving yourself is perhaps the wisest investment you can make *right now*. Your future success and happiness could hinge on your mastering a certain subject or acquiring a special skill. But there are obstacles. You may have a family to support. Or a job to hold down. You may feel you're too old to learn.

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- ☐ Magazine Illus.
- ☐ Sign Painting and Design'g
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- ☐ Auto Body Rebuilding and Refinishing
- ☐ Auto Engine Tuneup
- ☐ Auto Electrical Technician
- ☐ Diesel Engines

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- ☐ Aviation Engine Mech.
- ☐ Reading Aircraft Blueprints

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- ☐ Advertising
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- ☐ Business Management
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- ☐ Industrial Engineering
- ☐ Industrial Instrumentation

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- ☐ Machine Shop Practice
- ☐ Mechanical Engineering
- ☐ Plumbing and Heating
- ☐ Professional Engineer
- ☐ Quality Control
- ☐ Reading Shop Blueprints
- ☐ Refrigeration and Air Conditioning
- ☐ Tool Design
- ☐ Tool Making

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- ☐ Industrial Electronics
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- ☐ Radio-TV Servicing
- ☐ TV Technician

RAILROAD

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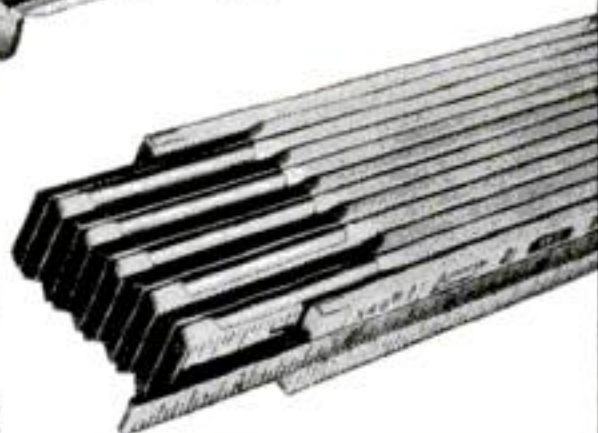
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SAGINAW, MICHIGAN

down from altitude, a sudden explosive decompression took place. (We later found this was caused by a water jug tossed through a rear blister by one of the crew, preparing for bailout of his personnel.) At the same time, contact was reestablished with the rear and damage determined: The complete loss of No. 3 engine which took a large portion of the left flaps and part of the wing structure with it.

We were now too close for a good emergency landing and we had to go around and make a better approach. After landing, the cause of all our woe proved to be an internal fire in the wing caused by a shorted wire.

All that saved the crew was luck. When the engine separated from the aircraft, the fuel and oil lines were pulled off, allowing them to trail overboard. We couldn't close off the valves to them because all the wiring was burned out of the wing.

M/SGT. W. J. TOWNSEND, Otis AFB, Mass.

If You Wear Glasses . . .

YOUR tricks of the cheats ["Exposing Crooked Gamblers' Tricks," Jan., p. 61] omits one of the most obvious. I quit playing cards because, unless I held the cards in some clumsy fashion, other players could



see reflections of my cards in my eyeglasses. If you wear eyeglasses, don't even watch card games; you're helping someone to cheat.

BERNARD BERGER, Pittsburgh.

73 from K9SQH

IN THE piece on Citizens Band two-way radio ["The Radio Party Line," Feb., p. 139], you say that "already, CB has more than twice as many licensees as 50-year-old amateur radio." How about that?

Anyone who can write and is over 18 can get a CB license just by writing to the government for it. But to get an amateur or ham license, you must put in many hours studying for it—learning code, practicing for speed, and boning up on operating rules and procedure. Then you must pass both code proficiency and technical tests, all at your own time and expense.

CBs do lots of good, but let's not compare them to hams who have to earn their li-

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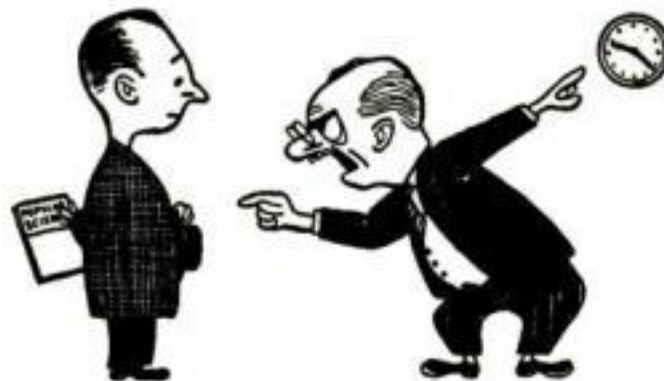
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censes. For years, hams have aided at all major disasters and they're running communications for a big part of Civilian Defense.

R. L. ROGERS, Decatur, Ill.

Hazards of Reading PS

ONE thing missing in "How to Gain an Extra Hour Every Day" [Jan., p. 117]. So



absorbed reading it, passed my station this morning. How read PS and avoid station passing?

JOS. SINGERMAN, Forest Hills, N.Y.

Spending \$100 for Safety

THE best safety promoters for drivers are common sense and public education. But along the lines of the Detroit list ["Car Men List Favorite Safety Devices," Jan., p. 102], I'd like these inexpensive items:

1) A resistive heating element in the defroster exhaust ports to give instantaneous de-icing and clearing when the motor is cold—with switch-controlled or thermostatically controlled cutout.

2) A better system of outside rear-view mirrors that don't blind you, but afford a direct view.

F. B. HORNER, Allenhurst, N.J.

... I SEE Harry Doane of GM says headlights are the best they know how to make. He'd better stop patting himself on the back and consider the fog hazard. When you are looking into a brilliant wall of shining droplets, you just can't see. Every time it gets soupy in this area we have big pile-ups.

The little horizontal flats in the headlight lens bounce light upward where it does no good and in fog is an abomination. Here's one place where at virtually no cost, we can improve these "best" headlights.

Why couldn't the offending flats be eliminated or refocused? The little metallic shield over the filament helps, but it only controls direct light, not that reflected from the flats in the lower half of the lens.

R. H. EDWARDS, Compton, Calif.

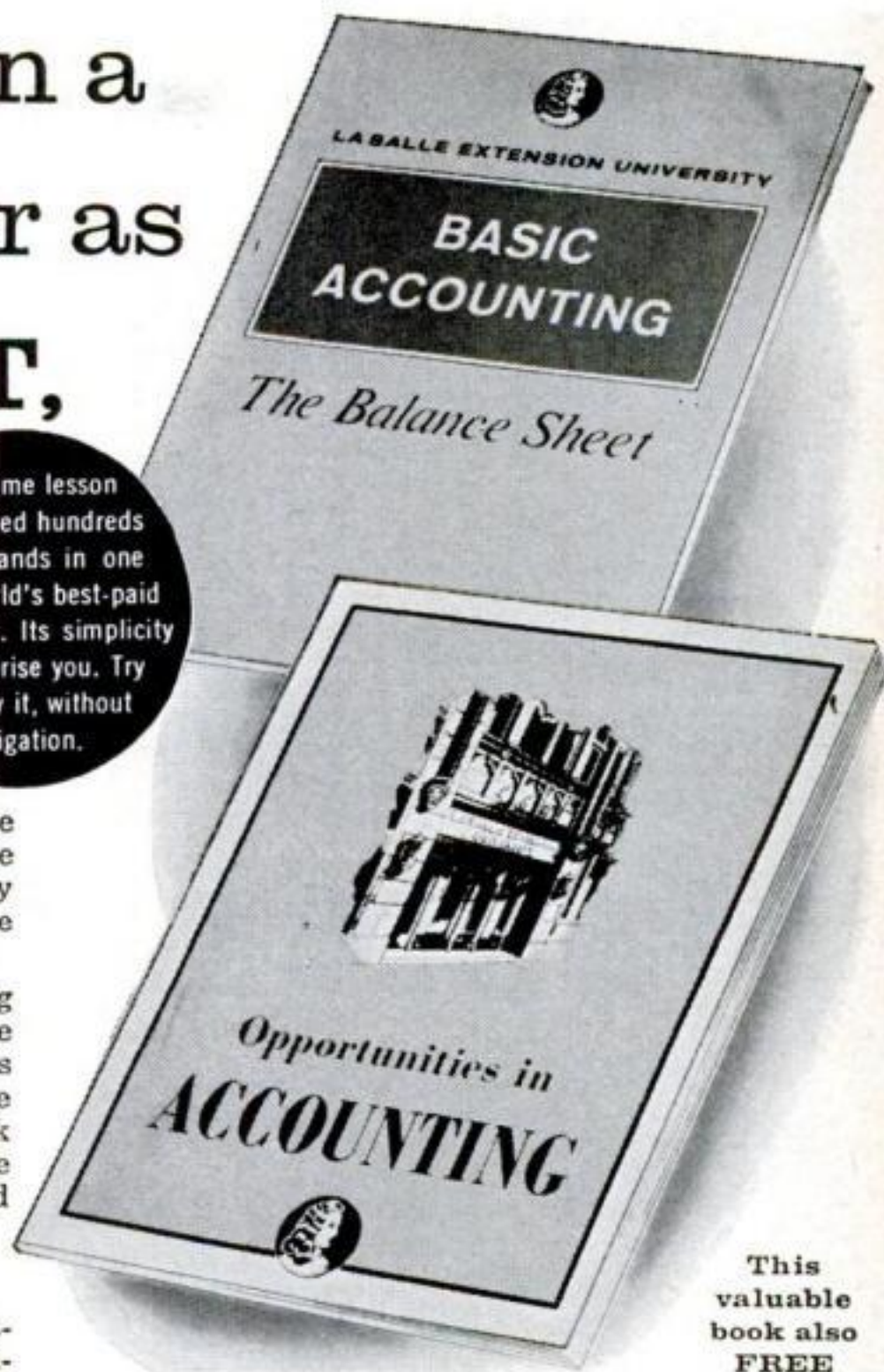
... ONE of the greatest safety aids—and one that would cost nothing—would be some method of indicating to another driver that his turn signal is flashing long after he's made his turn.

It is common practice to blink your head-

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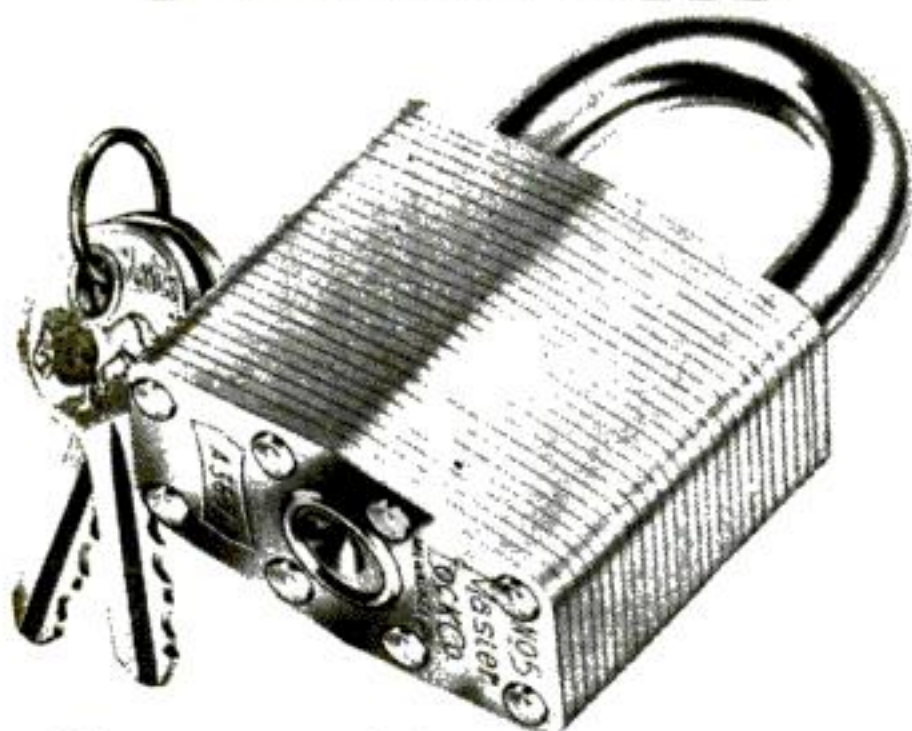
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lights at an oncoming motorist to warn that his headlights are on high beam. Why not blink directional lights—first right, then left—to signal another motorist to turn his off? This would work on a long stretch of road.

C. L. JOHNSTON, NYC.

... HERE'S a practical and inexpensive safety measure: For the last 25 years every car I owned has been of a very light color and/or has had some broad reflective surface. I would much rather have the other driver's headlights reveal my car more readily than have a color that is picked up so late by his headlights that a crash is inevitable.

W. S. ALTMAN, M.D., Quincy, Mass.

... WHERE would I spend \$100 on safety? On tail and stop lights. I'd like separate locations—one at the roof line, the other at the bumper. The intention of the car would then be indicated by position and not by intensity. And I'd like to see amber-colored turn signals like those used on trucks.

FRED B. OLLETT, JR., Cincinnati.

The auto makers are ahead of you. See "Detroit Report," page 70.

... I DISAGREE with Chrysler's Mr. Haeusler. Car handling—that mushy, living-room ride—is a foremost cause of accidents. The suspension, steering, weight distribution, balloon tires, and general roadability give us driving without feel.

The power steering of some models gives one the feeling that the car cannot be steered but must be aimed. The driver can



only suggest the direction. (This is positive steering?) On some cars with power brakes, touch the pedal a little too firmly and you go through the windshield, lose control, or get rammed from behind. The automatic shifts have caused numerous accidents because they invite driver error.

C. T. PATER, McKeesport, Pa.

... AUTOMATIC headlight switching never fails? I drive a truck 80,000 miles a year and I can tell GM's Mr. Gandelot that I've been blinded by another driver's high beam many times until I finally flashed mine. As my brights came on, his automatic dimmer would operate at exactly the same instant. This instantaneous response occurred so often it had to be automatic. Yet my low

CONTINUED



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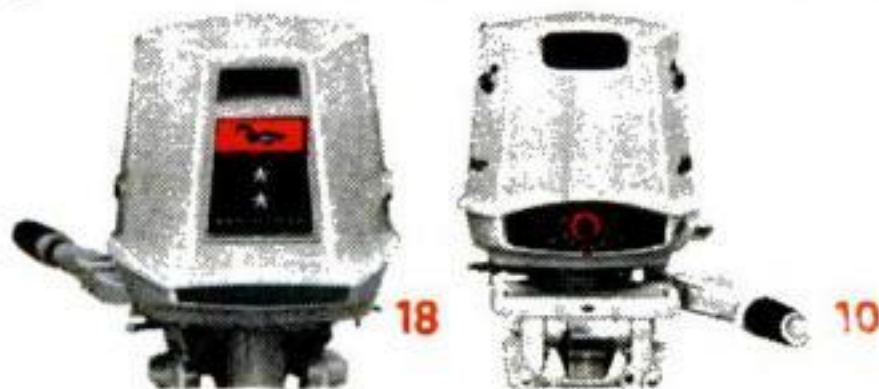
New Johnson *Compacts* . . . above is the 5½, below are the 18 and 10. Their small size is the big news. Clean and simple. Lighter and smarter. Function, not flash. These motors are made to go fishing, not flying.

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Visit your Johnson dealer's. He's in the Yellow Pages. '62 Sea-Horse motors include Electromatic 75 and 40 hp models (with outboarding's first truly automatic transmission); a high-performing 28; and a 3 we find impossible to improve.

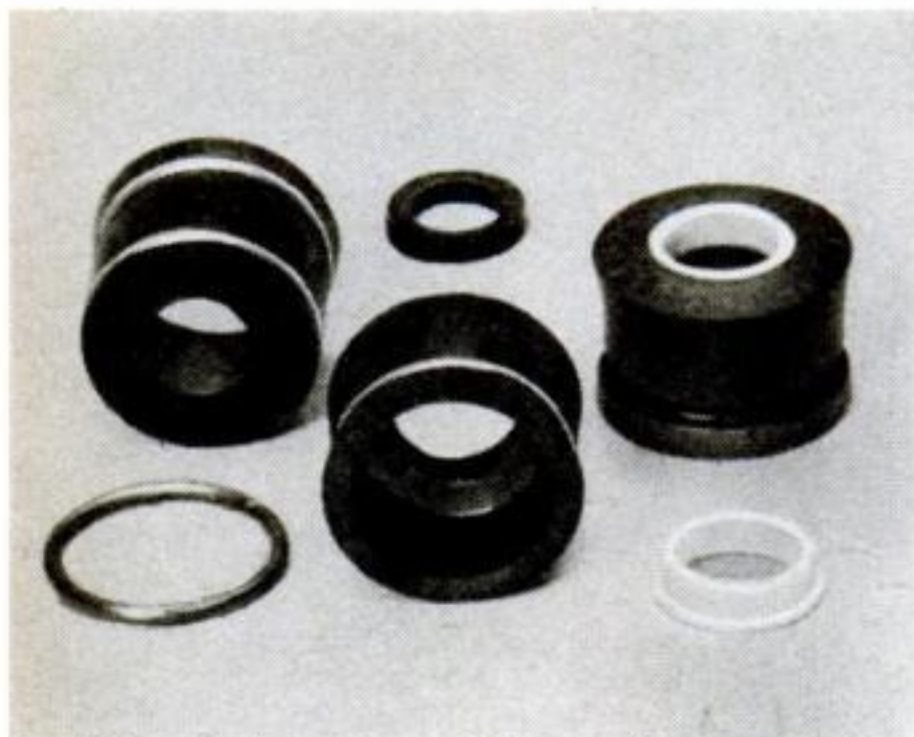
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2. What does this symbol stand for?

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beam is plenty bright enough to trigger an automatic control that's working properly.

Automatic light dimmers make lazy drivers get into the bad habit of shirking their responsibilities.

BURTON BROWNING, Howell, Mich.

Not for Spaniards

THE razor guide to keep sideburns even ["New Ideas from the Inventors," Dec., p. 84] tickled me. I discovered several years ago that I could achieve the same result by leaving my glasses on while shaving. They act as a road block and results are perfect.

J. F. MARSHALL, Newburyport, Mass.



Your world of appreciation grows bigger with everything you read. Celebrate National Library Week, April 8-14, with a good book.

The Imports Have It

BETTER have Mr. Kibler ["I'd Like to See Them Make," Jan., p. 92] purchase a Peugeot. My 1960 station wagon has a one-piece door and gas cap, made of rubber, behind the swinging tail-light section. Works fine, can't get lost, and no dirty fingers.

G. D. C. ORTON, Waterbury Center, Vt.

... THAT combination door and cap for automobile gas tanks a reader "would like to see" has been on BMC's Austin, Morris, and MG Magnette (sedan) since 1959.

W. M. PLUMMER, Port Republic, Md.

... TO SEE a combined door and cap for gas tanks, look for the nearest Jaguar. My 1951 XK-120 Roadster has one, as do Jaguar sedans and limousines. The little door even has a built-in lock.

DAVID ROTHSCHILD, Morristown, N.J.

He Says It Won't Work

I ENJOY "New Ideas from the Inventors" and have a bit of advice for one hopeful: the inventor of the jack extension [Jan., p. 109] for leveling a car while raising either end off the ground.

An unfortunate experience with a rather sturdy tripod design of the ratchet-and-notch bumper jack convinced me that this jack is not designed to raise the weight of

CONTINUED



**moving machine
either side of the line!**

Pontiac Catalina

There's a good deal more to driving than a straight-line quarter-mile, and nobody knows that better than the performance-minded. Which is why Pontiac's Catalina shows up so often among you people.

One of the reasons for this popularity is the choice of engine/transmission teams. Standard equipment is a 215-hp Trophy V-8 hooked up to a three-speed stick, of course. But you can get a storming 405-horse engine and heavy-duty four-speed as extra-cost options. And other extra-cost options blanket the area in between, including automatics.

Wide-Track and Pontiac's own special han-

dling precision come standard with the Catalina, naturally. So does a fat helping of pure luxury.

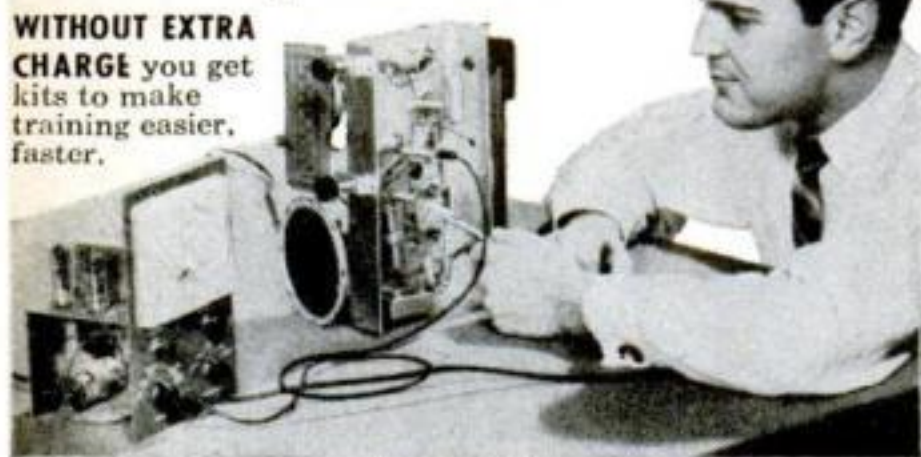
The great thing is that a new Catalina goes easy on your bankroll—this is Pontiac's lowest-priced full-sized series. Talk it over with your Pontiac dealer first chance you get. Plan to spend some time with him—you could use up a whole day just looking through that list of options, and a happier time you couldn't imagine.

(Oh, and if you'd like to check your Cat against the clocks, feel free. No fair making the Catalina do the pushing while the dragster has all the fun.) Pontiac Motor Division, General Motors Corporation.

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Broadcasting.

"I am now chief engineer of Station WARA. NRI was the foundation." R. ARNOLD, Attleboro, Mass.



Industrial.
"Four months after starting your course I went to work at Raytheon. Now I am an engineering assistant in Microwave Power Tube Research." L. J. BLOOM, Newton Centre, Mass.

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my car ('49 Chevy). When the whole front end was raised, great care had to be taken to avoid taking "divots" out of the lift bar. This would frequently happen when play in the ratchet caused it to seat only partially in its notches. The extra stress was too much for it, and a couple of these operations almost ruined the jack.

I think that jack-extension inventor will find he needs a more sure-acting ratchet, or a sturdier lift column.

HERBERT SLADE, Maplewood, N.J.

Tips to the Tipsters

ABOUT that wedge vise from T&G flooring ["Short Cuts and Tips," Jan., p. 196]: The writer says that leaving the groove on the inside of the backstop improves holding power. Frictional force depends upon the coefficient of friction and normal force, not upon area. There is no more holding power, with or without the groove.

If you want more holding power, I suggest leaving the plain side on the inside of the backstop and gluing a strip of sandpaper to it. Use discretion in selecting the sandpaper; the coarser the paper, the better the holding power; but too coarse a paper might mar the work.

N. F. DANN, Orono, Me.

. . . IN YOUR "Nailing Know-How File" [Feb., p. 165], you missed one very important point: When driving nails, clean the



face of the hammer with fine sandpaper. This almost eliminates bending, particularly of thin brads.

An old school teacher, who taught me this, prided himself on being able to drive a common pin into solid oak.

Very few could win at the old carnival game of "driving the spike" simply because the operators kept the hammers slippery with the oil from their hands.

R. E. THIEL, Richmond Hill, Ont.

. . . THE man from Atlanta who describes a pocket rifle cleaner ["Short Cuts and Tips," Jan., p. 162] is describing his version of the British "Pull-Through." This is usually a bullet-length bit of brass rod into which an ample length of braided cotton twine has been crimped, with a loop at the other end to accommodate a bit of rag. It is stowed in a

CONTINUED



Air Force Recruiter to Howard Adcock, Gadsden, Alabama:

"Let's talk about your next important step."

Today the Air Force plays a key role in the defense of the free world. Its members must work with increasingly complex techniques and equipment. There is little place for the untrained, unskilled. Such are the facts of life of the Aerospace Age.

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U. S. Air Force



Howard Adcock
who is shown above is now an Airman 3C. He is with a Fighter Wing stationed at Myrtle Beach Air Force Base, S. C. As aptitude tests had predicted, he is doing well in his job as an Organizational Supply Specialist.



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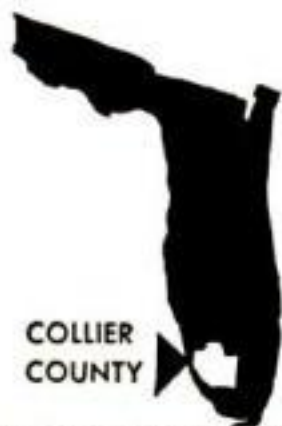
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specially drilled hole in the stock, stoppered by a spring-loaded cap in the butt plate.

J. A. PHILLPOTTS, Montara, Calif.

. . . READERS who can't use the tin-can method for cleaning out gutters ["PS Readers Talk Back," Jan., p. 14] might like to try my way.

My ladder isn't long enough to reach the second story and, besides, I didn't want to take the risk of cleaning from the edge of the gutter, then moving the ladder each time. I placed the ladder at one end of the gutter, put a safety rope around my chest, and fed a solid stream of water into the gutter with the garden hose. My gutters are of the box type with drive-through fasteners every 10 feet. The hosing cleaned them out so cleanly they shine. I did get a bit wet, but the job was fast and safe.

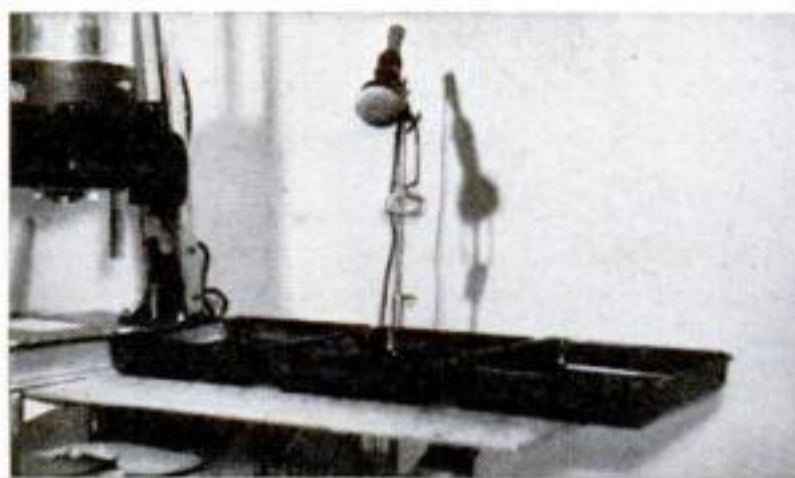
E. C. BLACK, Columbia, S.C.

. . . I OFTEN measure internal threads by the bismuth-alloy proof-casting method ["Short Cuts for the Machinist," Feb., p. 153], but I wouldn't use "Cerro-safe." The size changes after solidifying of the alloy require that you make your measurements at approximately one hour and the casting would be lost as a reliable reference for the future. I use Cerro-low 117. This melts at 117 deg. You'll find a +.0002 reading in 6 min. to .0000 in 30 min., and —.0002 from 2 to 500 hr. The low melting point will be less hazardous and the alloy fills into small cavities much easier.

LARUE WEILACHER, Ridgway, Pa.

Just a Careful Guy

IF I owned the darkroom shown at the top of the page in "Lighting Tips for a Pho-



tographer" [Jan., p. 154], I wouldn't worry about where I put my safelight. I'd worry about that tray on the end of the table. A fly, a cough, a sneeze, or a hard stare could send it and its contents sailing. Tell the man who owns the setup he'd better get a bigger table or a good mop.

PAUL LANCASTER, Phoenix.

Testing the Chevy II

I OWN a Chevy II; four-cylinder, manual shift (3.08:1 rear-axle ratio). Naturally, I



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was interested in your report ["10,000-Mile Test of New 4-Cylinder Chevy," Jan., p. 68]. We agree on one point: It is a very contradictory car! Points of difference:

1) Top speed with my 6.50-by-13 tires seems to be 85 m.p.h. Yours: 90 plus.

2) Acceleration from 0-60 m.p.h. in 17 sec. reported by you seems questionable with a 157-cubic-inch engine and 3.08:1 rear-axle ratio. One of the motor magazines reported 20.8 seconds.

My overall conclusion is that it should have good life expectancy. I like the way it is made—zinc-coated parts, five mains, and so on—and I like the ride.

I note that all your tests of the car were made with standard (6.00-by-13) tires. Could you tell me what change these would make in the speedometer reading?

D. W. GILBERT, Kent City, Mich.

None.

... AFTER reading the test report on the Chevy II, and recalling previous tests of the Tempest, F-85, Falcon, and so on, I got to wondering. What happens to these cars after you finish the 10,000-mile trial runs?

MARTY STEIN, Silver Spring, Md.

The cars are sold on the open market like any used cars.

... A FOOTNOTE to your Chevy II article stated that modifications (running changes) were made, effective Nov. 27, to correct its faults. I purchased a '60 Corvair just after their first appearance and this brings up a question:

How is it that auto firms proclaim that cars have been tested for months, possibly years, and then make major changes just after a showroom debut? Owners seem to be able to find out any faults in a hurry. Your drivers point out errors immediately. One is



led to believe these cars were tested in the cafeteria of the maker by a trained chimp.

LLOYD ALLEN, Toronto, Ont.

... NO ONE can really appreciate a four-cylinder engine until he takes a drive in a Mercedes-Benz 180 or 190.

CARL A. VOEGELI, Port au Prince, Haiti.

... WHILE you give the indicated and actual speed, you don't give the indicated



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exhaust outlet near the surface. Jet-Prop literally drowns exhaust noise and, at the same time, improves the engine's breathing and reduces underwater drag.

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MERCURY

*100, 85, 70, 50, 45, 25, 9.8 and
6 horsepower outboards*

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miles traveled and the actual miles traveled. They can be quite different.

EMIL MILLER, Huron, S.D.

In calculating gas mileage, we have compensated for odometer error.

Shop Vacuum Makes a Hit



IT WAS a real pleasure to construct the shop vacuum cleaner from one of your bonus blueprints of last year [Jan. '61, p. 187]. The materials cost me approximately \$50 and I'm very well pleased with the results.

I've made an adapter to use the cleaner on my shaper and bench saw. My basement shop is cleaner

and I feel well repaid for my work.

L. H. MURPHY, Pontiac, Mich.

... I SAVE my back issues. If I can't use the information right away, I often find it useful later. At present, I'm converting your sawdust vacuum cleaner into a leaf vacuum, using a 2½-hp. gas engine for power.

P. H. SCHMITT JR., Far Hills, N.J.

Machinists Extraordinary

THE Thomases ["Father and Son Build Dream Engines." Jan., p. 148] did a nice job of copying the Wankel engine. Why not simplify the design further and make the center housing round? It would be easy to machine the rotor round and avoid all that eccentric machining by just cutting out three or more chambers.

ED. KESSLER, Rocky Hill, N.J.

Steamboat 'Round the Bend?

WITH the growing popularity of boats, the conversion of standard auto engines to steam intrigues me. Certainly some of the advantages of steam power—quietness, simple reversing, low-cost fuel—might be worth investigating, together with other advantages in installation of low-profile opposed-piston engines (Chevy Corvair and VW).

These pancakes, converted to steam to eliminate the noise, cooling, and volatile-fuel problems, could be installed under the cabin floor without the problem of V drives or bulky engine enclosures. Modern flash boilers are small and compact, and would take little space on the aft deck. And for a boat, there's always plenty of water around for the condenser.

W. T. JOHNSON, Los Angeles.



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When to change oil:

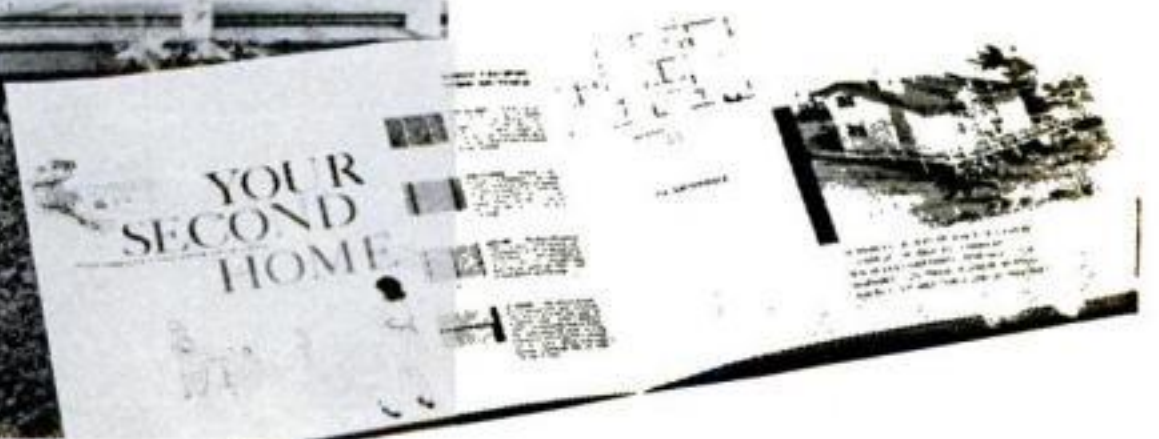
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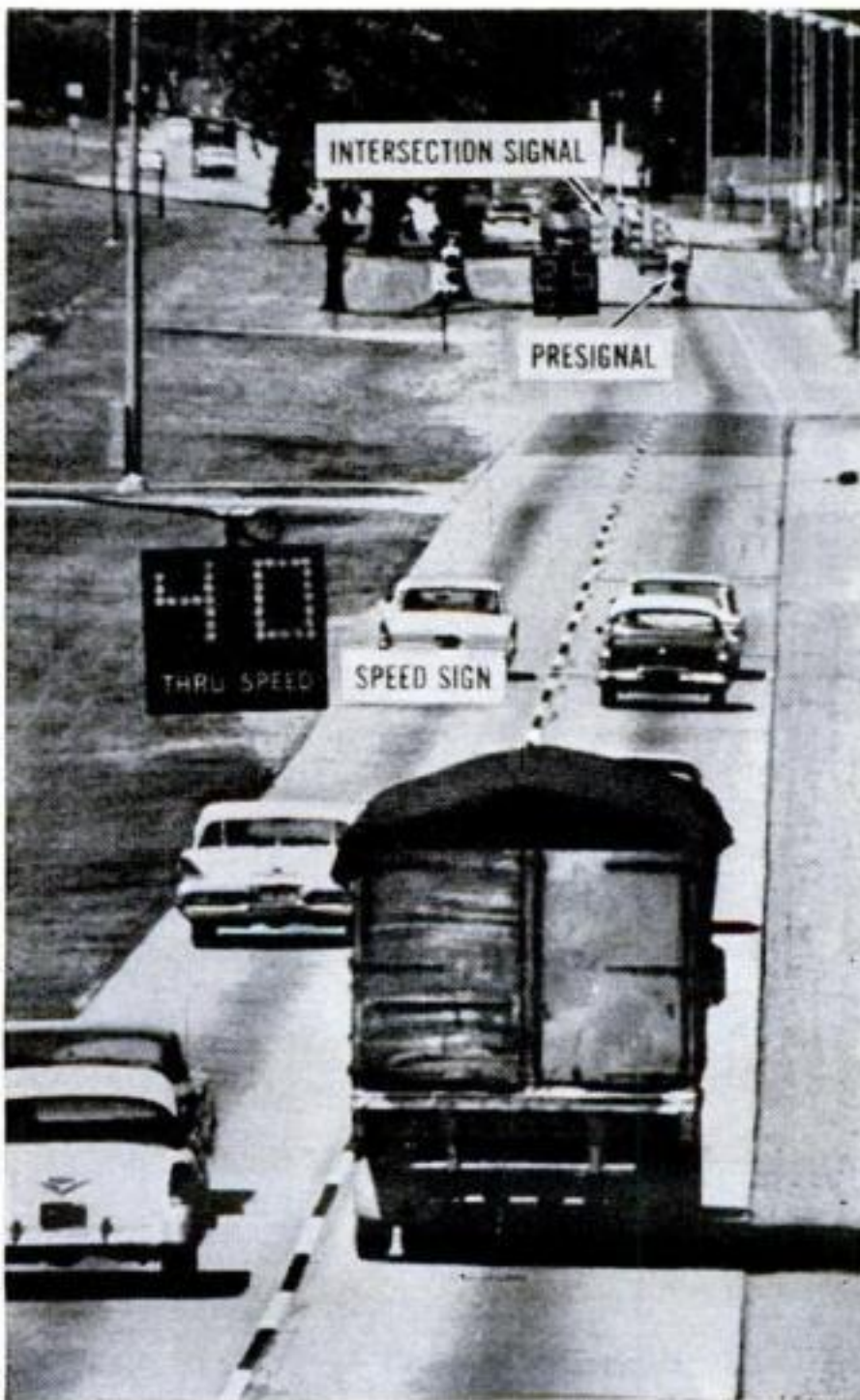
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The march of science

Will pill make fallout shelters obsolete? Look for announcement soon (maybe right about now) of drugs that prevent atomic rays from harming people. They could drastically alter military plans (and save many lives by easing radiation treatment of cancer). Anti-radiation chemicals (mostly sulfur compounds) have been around some time—but they are poisonous themselves. This problem seems to have been licked, and safe pills offering fair protection can now be made. Development has been under heavy wraps, partly for fear the news would mislead many people into believing that shelters are no longer necessary. The pills, while promising great value, aren't that effective yet.

How to beat the lights scientifically. If you drive along Mound Road in Warren, Mich., outside Detroit, you should be able to hit the green on every traffic light of a four-mile stretch. All you do is keep rolling at speeds flashed by signs.



SPEED SIGNS AND PRESIGNALS help motorists beat the lights in Warren, Mich., test installation. Picture, shot with a telephoto lens, distorts distances—speed signs are actually 921 feet apart.

Mound Road has the first American installation of Traffic Pacer. That is General Motors' name for its version of a nifty little highway scheme which was invented by Dr. Wolfgang von Stein of Düsseldorf, West Germany.

The idea is magnificently simple: Speed up the slow cars and hold back the fast ones on the through road so that they bunch into platoons. Then time the platoons to reach each traffic light just as it turns green. Between platoons, the through road is empty at the intersection and the light goes red to let cars out of the side road. Through traffic never stops, yet cross traffic gets an even break.

The old, old system of "progressive" signals—lights synchronized to turn green in a sequence matching the posted speed—is supposed to do exactly this job. Traffic Pacer tries to cut out bugs by putting in some extra complications.

Hanging out over Mound Road are big black boxes that say "Thru Speed" at the bot-

The march of science continued

tom and flash electrically lighted numerals above. They look (and work) much like the scoreboards at football stadiums. The speed displayed by a sign changes as cars pass beneath, bunching them closer together. A car racing ahead of a platoon may be slowed down by a 25-m.p.h. signal. The cars at the tail end of the platoon will be hurried along by a 40-m.p.h. signal. The idea is to concentrate the whole platoon into a tight group, so that as many cars as possible can cross the intersection during the 20 seconds that the light is green.

Oddly enough, the other addition to the highway controls is more stop lights. These "presignals" are installed ahead of the intersection. A car that would reach the intersection just as the intersection signal turned red doesn't get that far. Instead it is stopped in advance at the presignal. The presignal turns green to release the car early, too, so that it gets to the intersection just at the start of the green cycle there.

The presignal looks like a hindrance, but it's not. It gives cars a running start. They are stopped early so that they have room to accelerate and zip across the intersection at the top speed.

How well does it work? GM researchers recently reported a 12-week test. Compared to the standard progressive system:

- The average number of stops per trip was cut almost in half.
- Traffic flow was speeded somewhat.
- The time required for the average trip was not changed much.

.....

"It's a natural," Martin Mann, senior editor of PS and regular writer of the column above, exclaimed at lunch one day. "Somebody should do a book on all the exciting news in electricity: transistors, tunnel diodes, masers, the lamps that never burn out, the electronic gear they grow like tomatoes. And the background, too—from Benjamin Franklin to quantum mechanics."

Mann's enthusiasm turned into a book, just out, called *Revolution in Electricity* (Viking, \$5.95). It's a fast-paced account of the "quantum jumps" that electrical science has made just recently, from the first transistors to all the other Lilliputian wonders now finding their way into satellites, computers, and research laboratories.

A person with a "passionate desire to communicate" (as one editor phrased it), Mann has two previous books behind him: *Peacetime Uses of Atomic Energy* and *How Things Work*. Pipe-smoking, tweed-jacketed, and still young, he is nevertheless a veteran science writer. His career dates back to four years at M.I.T. as a physics major (who spent his outside-the-lab time working on the campus paper), four years of technical films for the Air Force, and now 16 years as an editor of POPULAR SCIENCE. He's an executive member of the National Association of Science Writers, and a founder of the Council for the Advancement of Science Writing. Though we who work with him admire (and are a little awed by) his skills, still it's humanly pleasing to note that when a tail light burns out on his sedan, the author of *How Things Work* goes to a garage to have it replaced.



Martin Mann

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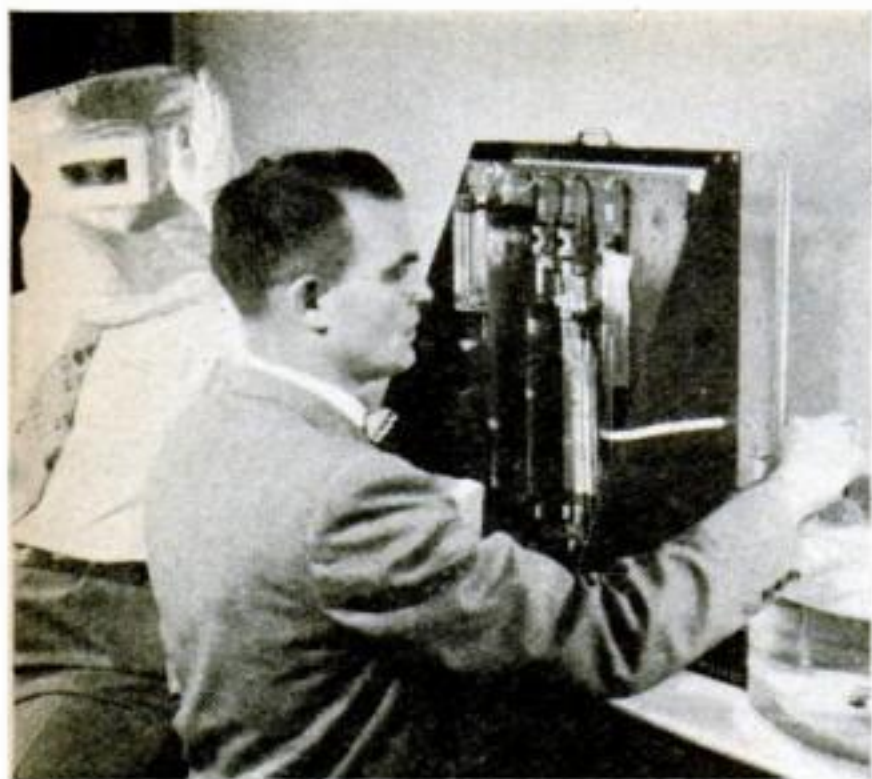
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It's a smelly job

The man in the plastic mask (above) is sniffing vapors fed to him from exhaust stacks of paper-pulp mills. His hand signal indicates to another researcher how much odor he detects. It's a step in a study by the Mead Corp., Dayton, Ohio, to identify malodorous vapors and transform them chemically into less objectionable smells. Pre-oxidation of pulp liquid and burning in the presence of a platinum catalyst are being tried.



TV men dolly in on kart

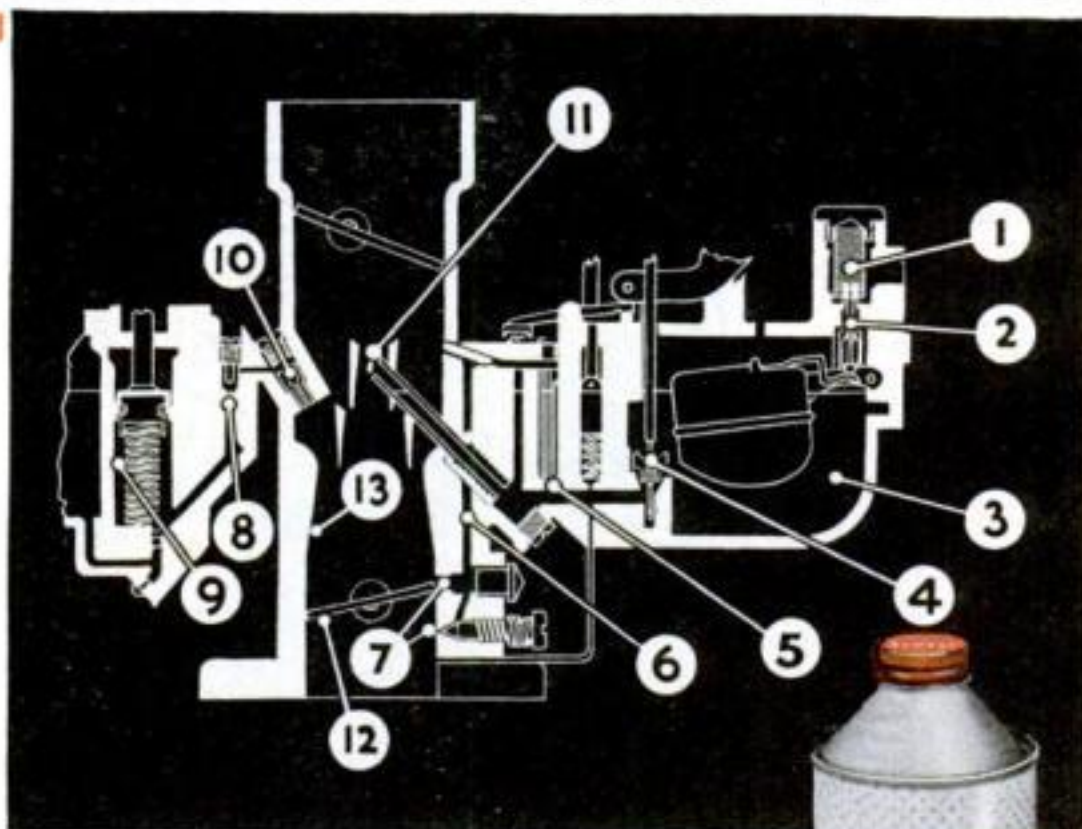
The problem of how to shoot moving subjects from a low angle has been solved by technicians at station KHOU-TV in Houston, Tex. They had a local racing-kart factory strip down one of its models and convert it into a mobile dolly with a platform in front. Then they mounted a television camera on the platform with the lens about a foot and a half off the ground. The rig is a low-angle brother of high-angle booms and utility trucks.

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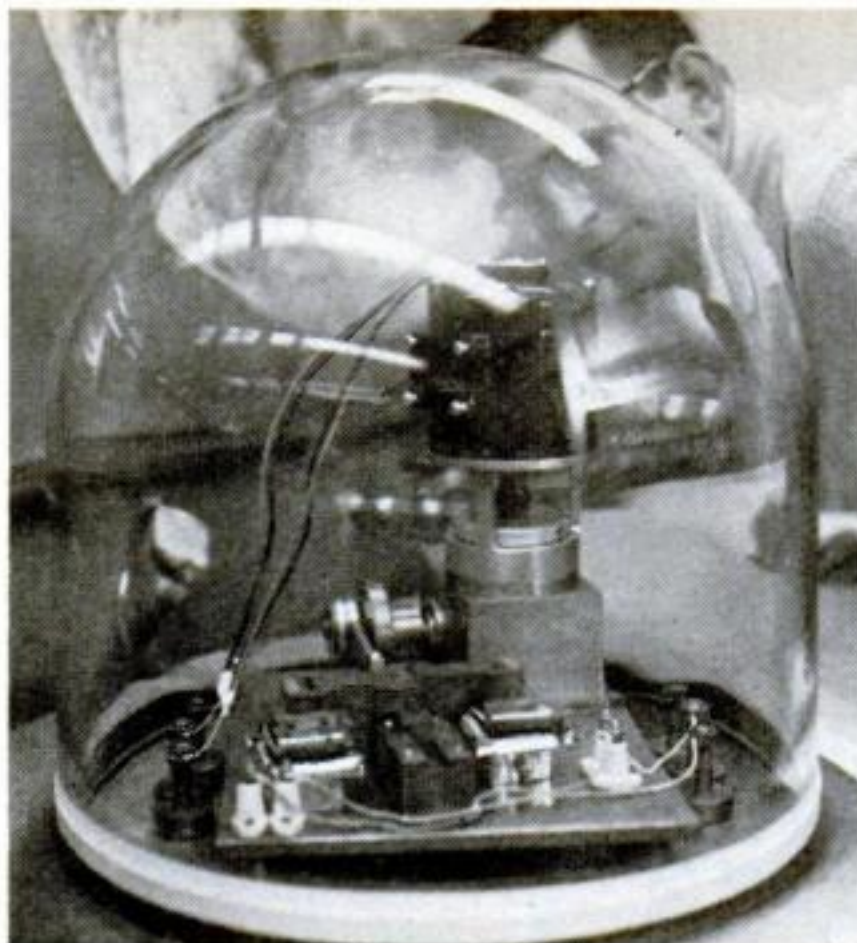
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Tensile strength, abrasion, and flexing characteristics of materials to be used in space suits are being tested in vacuum chambers by B. F. Goodrich scientists. In an airless environment, some materials lose volatile ingredients and undergo drastic physical changes. Special lubricants that don't evaporate are used in the machinery that rubs, stretches, and twists the materials being tested.



X ray for battlefield

It weighs only 85 pounds, but this compact, portable field X-ray unit works as well as the half-ton ones used previously, according to the Army Medical Service. The device provides a diagnostic X ray at such speed that it won't blur during chest radiography while the patient is breathing—especially important when he is dazed or unconscious. The machine runs on rechargeable batteries.



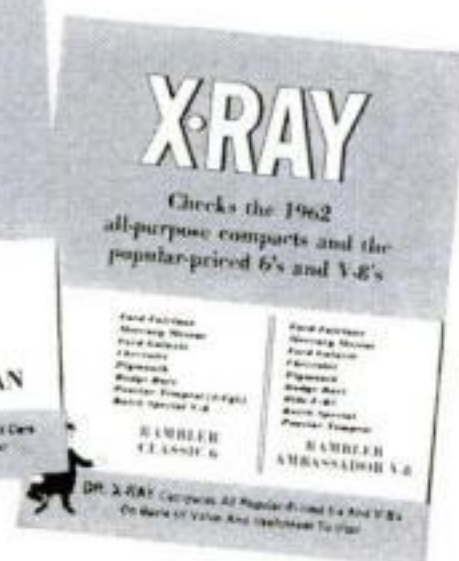
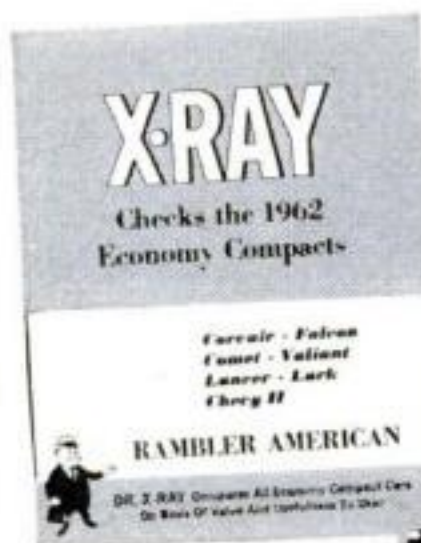
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Mechanical hoe

A tractor-drawn hoe that tills five acres in about eight hours has been designed at the Pioneer Agricultural Machinery Works at Strzelce, Poland. Shown above is the inventor, Karol Fogel, inspecting the prototype. The plant expects to manufacture 2,000 of the machines this year.



Giant space eye

It's like "replacing a porthole with a picture window," say Hughes Aircraft Co. scientists of their mammoth "monocle" for infrared detection systems in missiles and space-surveillance craft. The solid-germanium casting, a half-inch thick and 15 inches across, provides an extra-wide lateral angle of vision. It looks opaque as it's polished, but is optically clear at infrared wave lengths.

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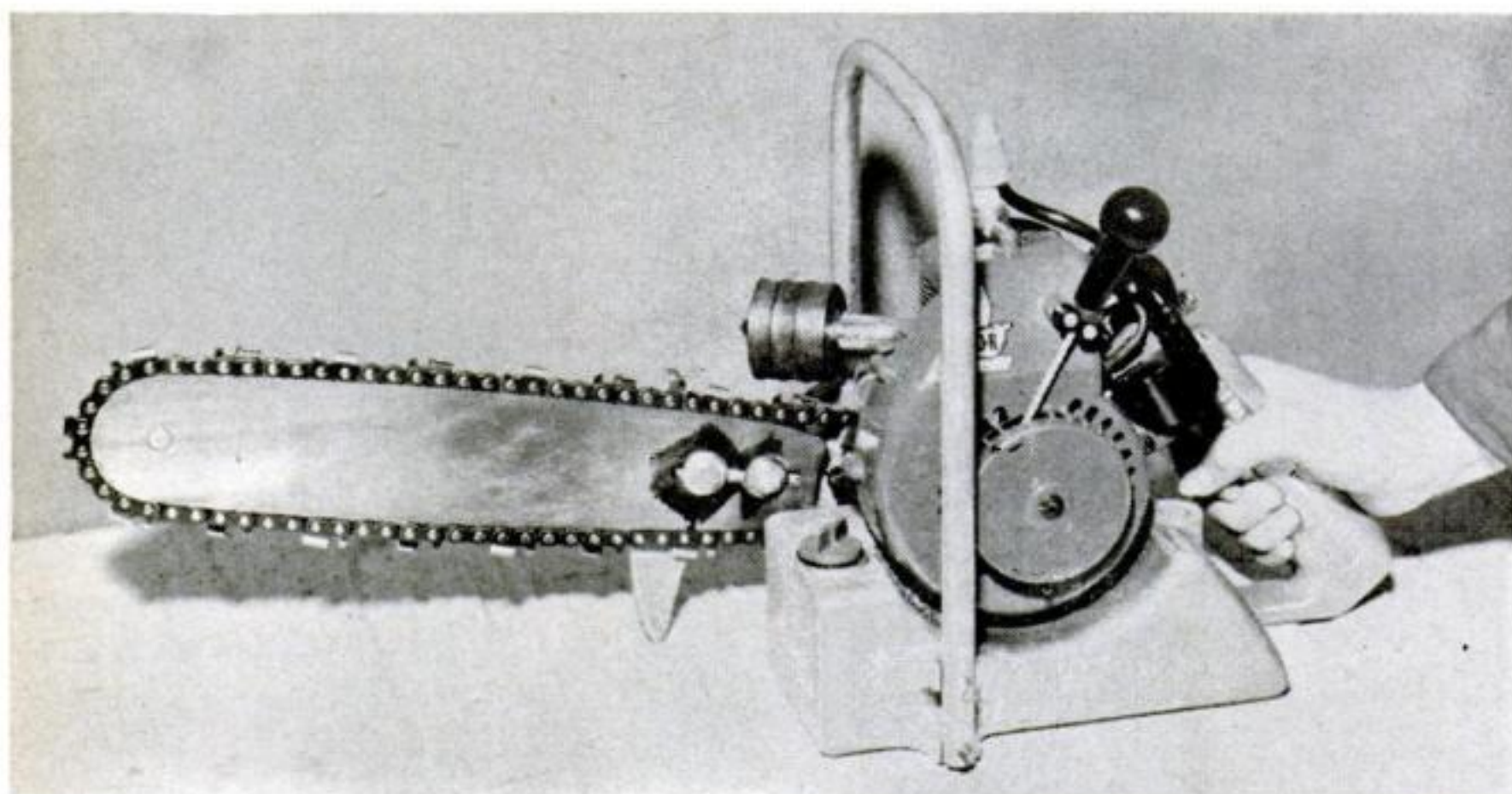
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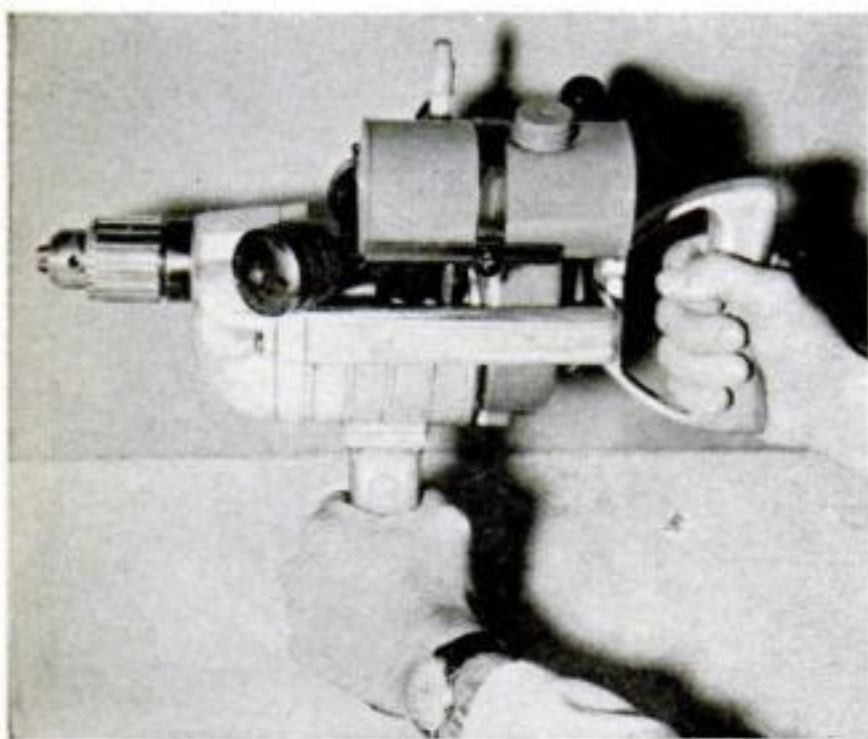
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New Tools Powered by Tiny Gas Engine



Nine-pound chain saw is one of the latest in a series of tools powered by the little $\frac{3}{4}$ -hp. Ohlsson & Rice gas engine announced last June. Its 9" blade slices 6" logs in 12 seconds (right). A throttle trigger lets you control cutting speed. The 21"-long Chip-A-Saw sells for \$118. Cenatron Industries, 5464 U. S. Route 99 S., Fresno, Calif., makes it.



Two new gas-powered drills also use the tiny Ohlsson & Rice one-lunger. The one above weighs 10½ pounds and has a $\frac{1}{2}$ " chuck. Engine speed of 6,300 r.p.m. is geared down to 300 r.p.m. for high torque in tough materials. Price is \$139.50 from Petro-Powered Products, 8742 E. Garvey Blvd., S. San Gabriel, Calif.

Almost all engine, this different-looking $\frac{1}{2}$ " drill uses a simple tubular hand grip. Its $\frac{3}{4}$ hp. produces 600 r.p.m. at the chuck. Weight is 8 pounds; length, 12". Price is about \$100 from Drillgine, 14873 E. Firestone Blvd., La Mirada, Calif. Both drills have engine-kill switches.



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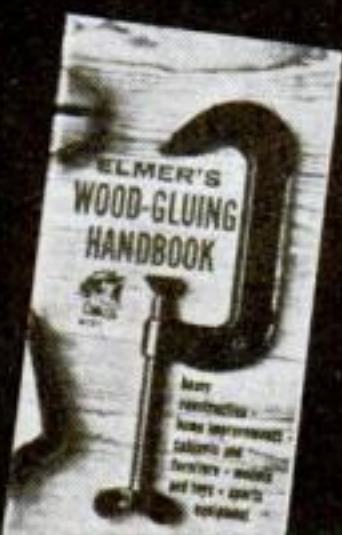
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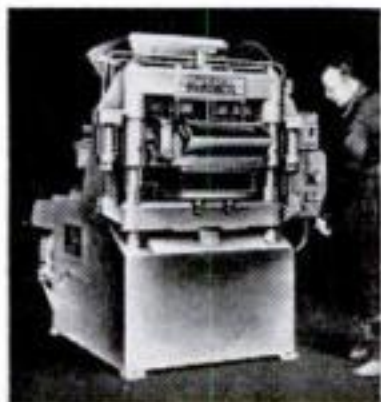
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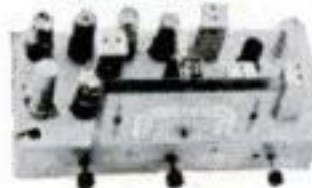
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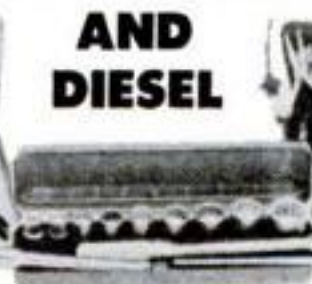
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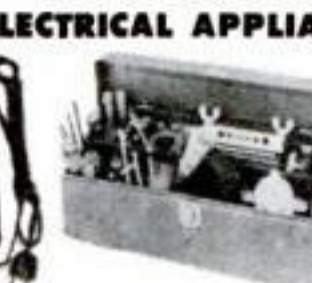
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38 POPULAR SCIENCE APRIL 1962



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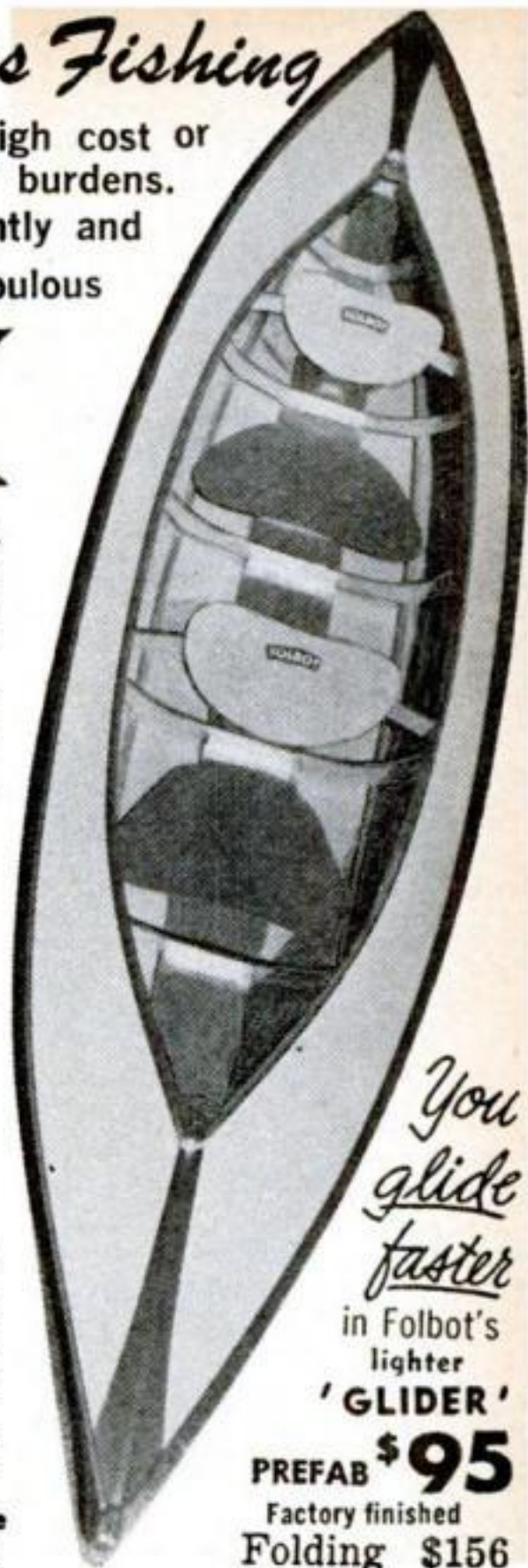
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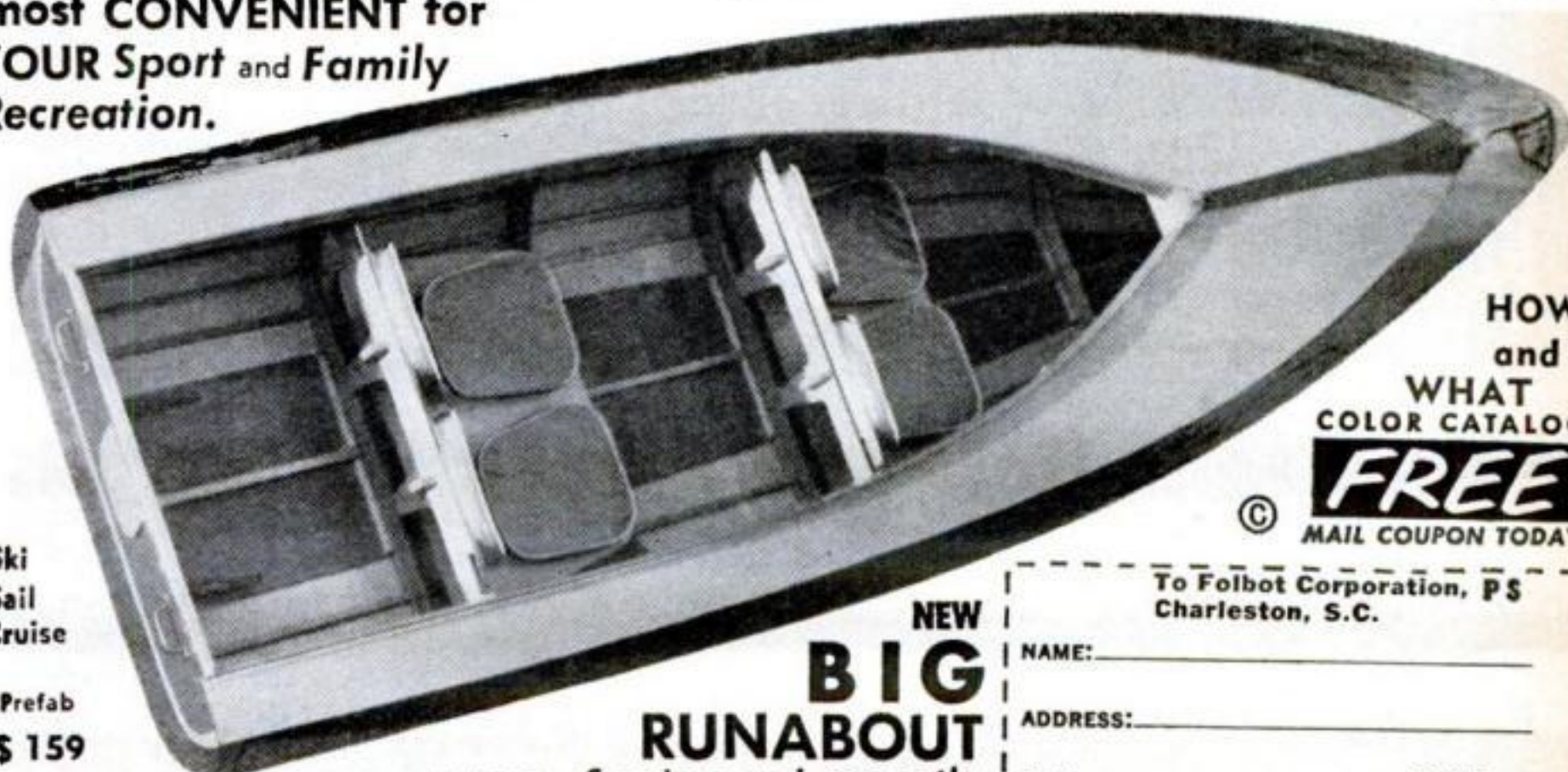
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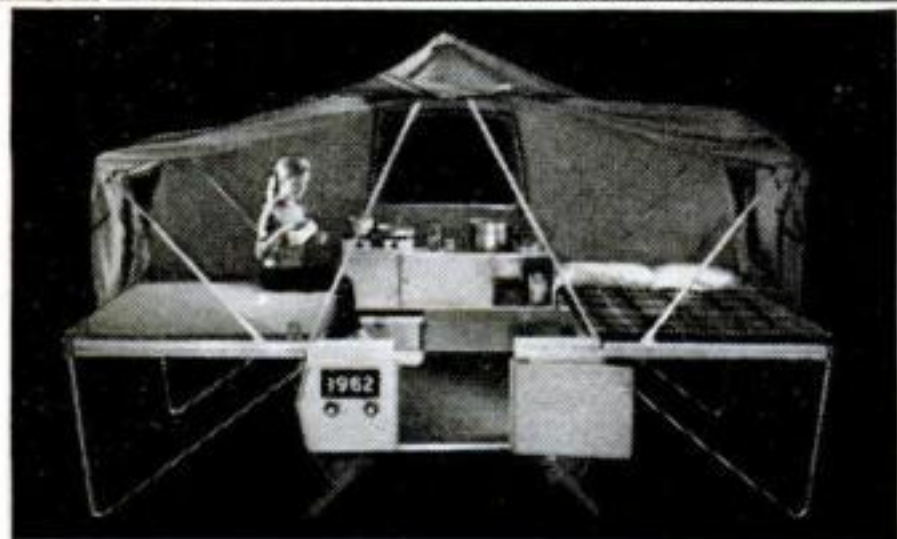
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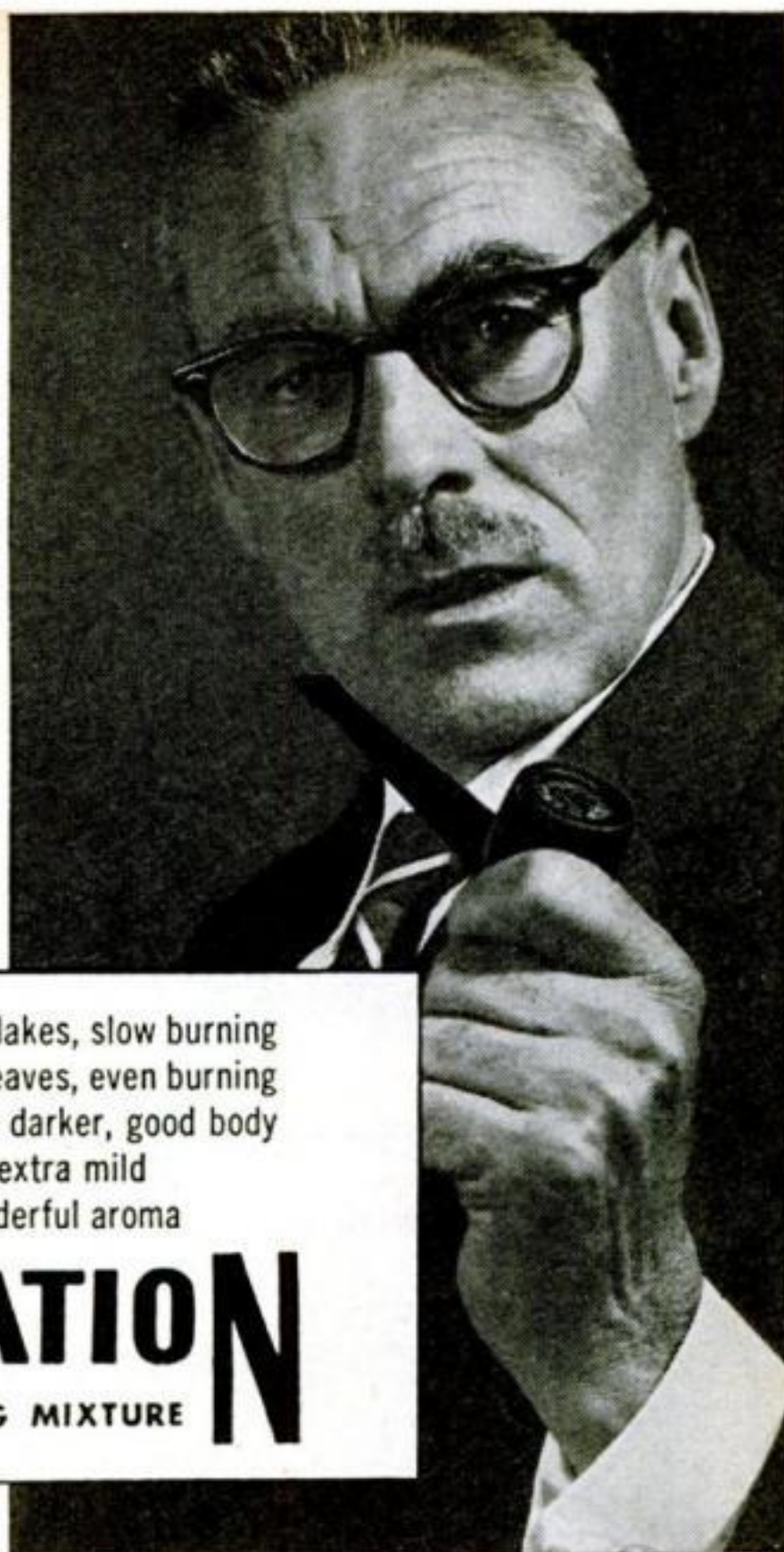
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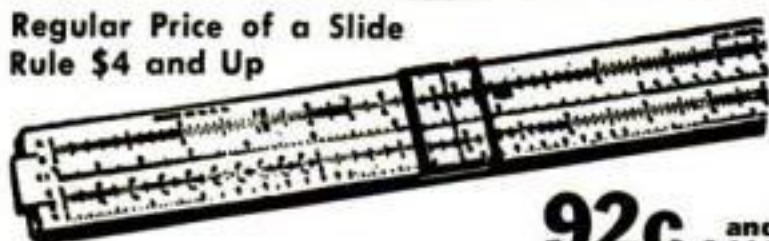
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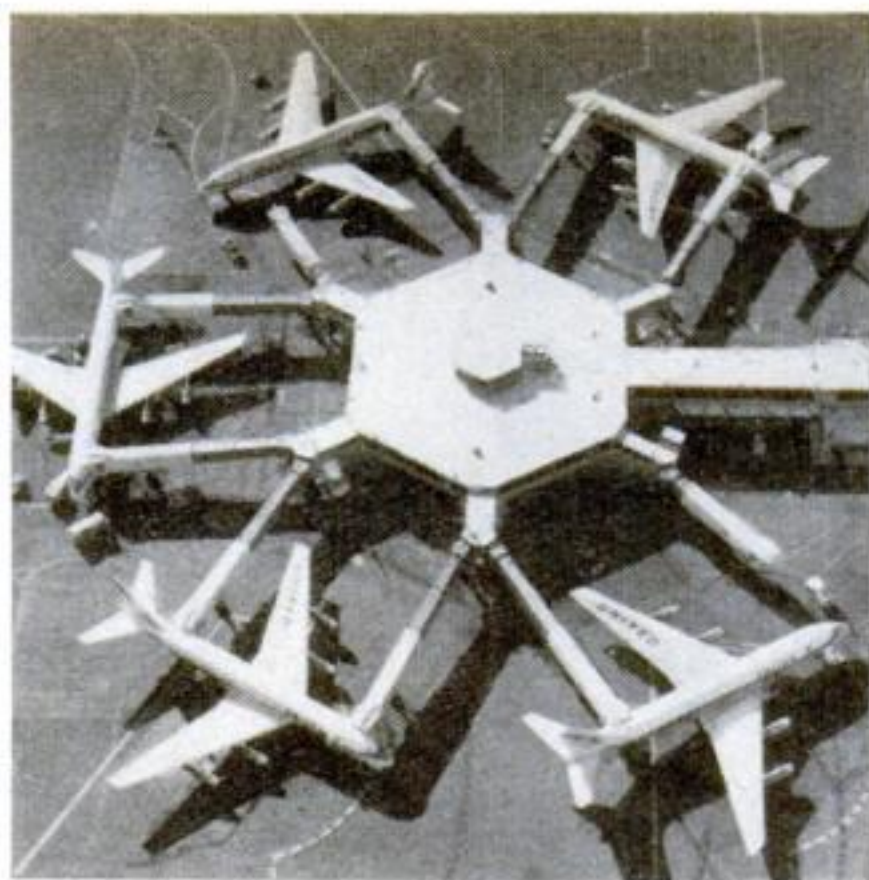
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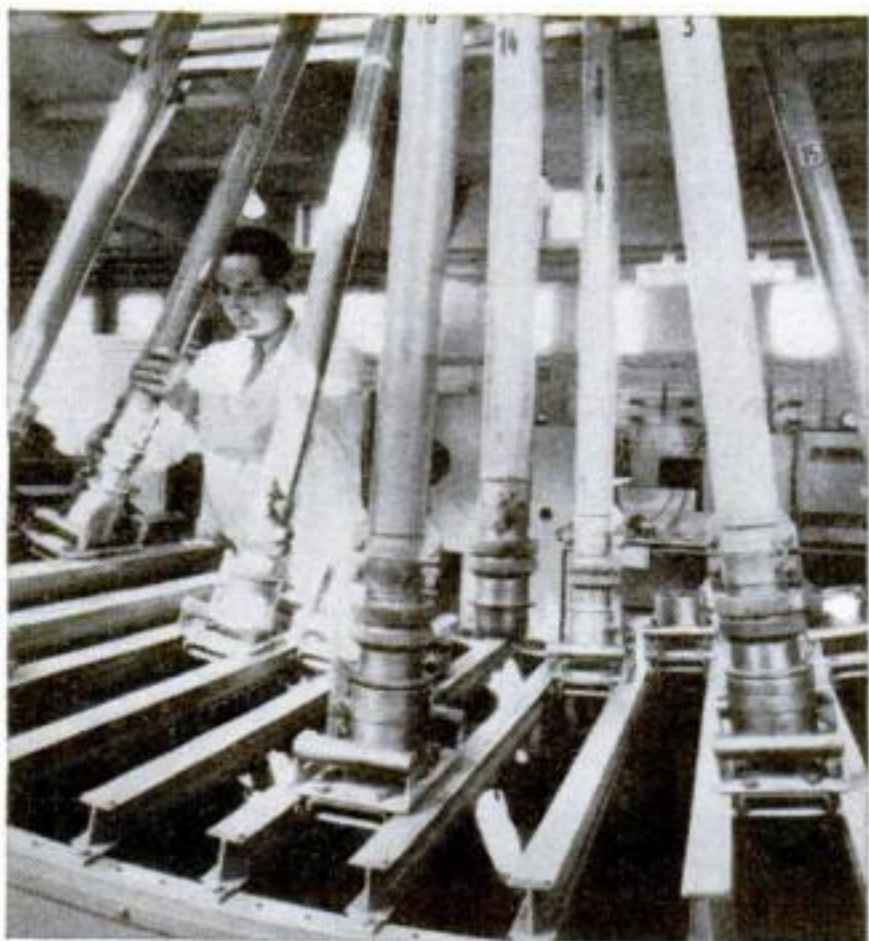
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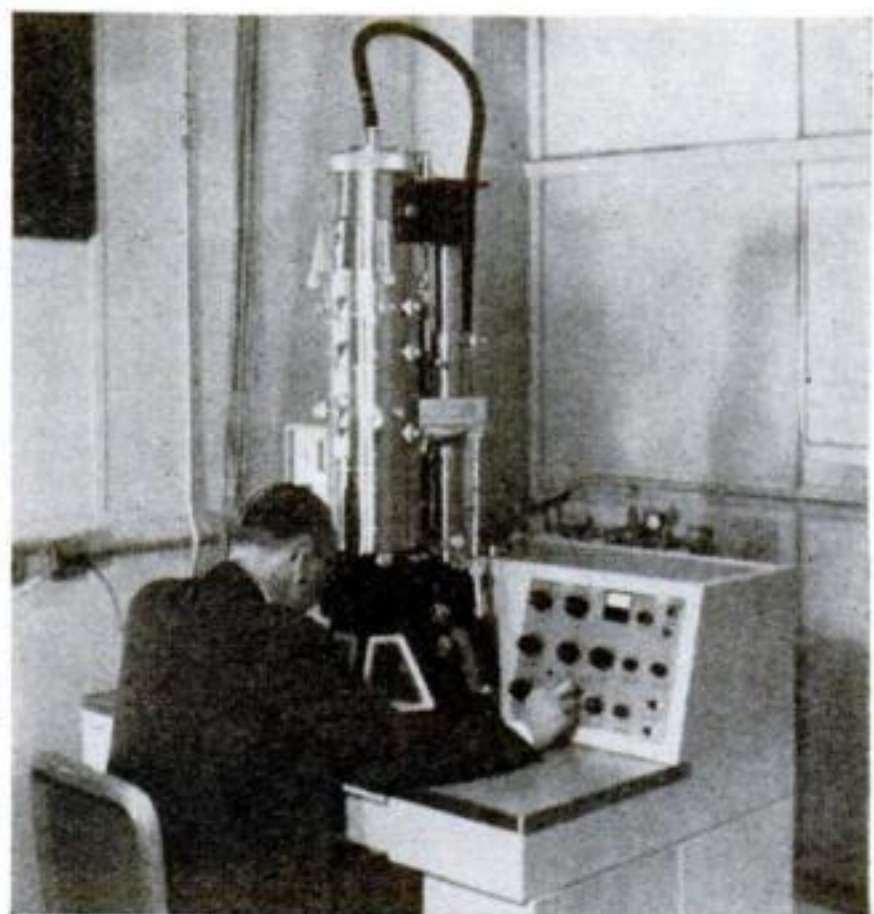
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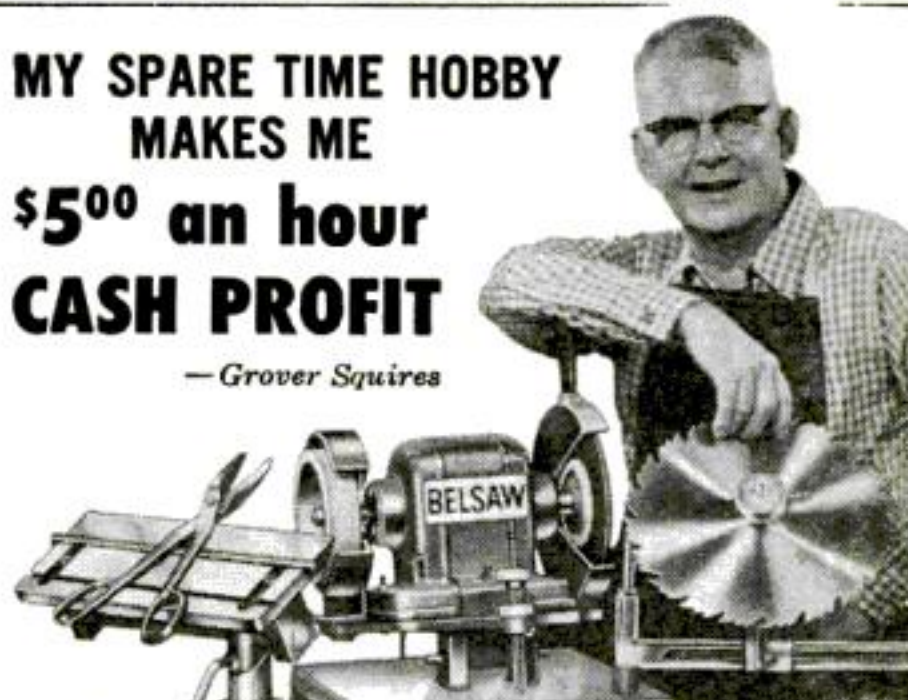


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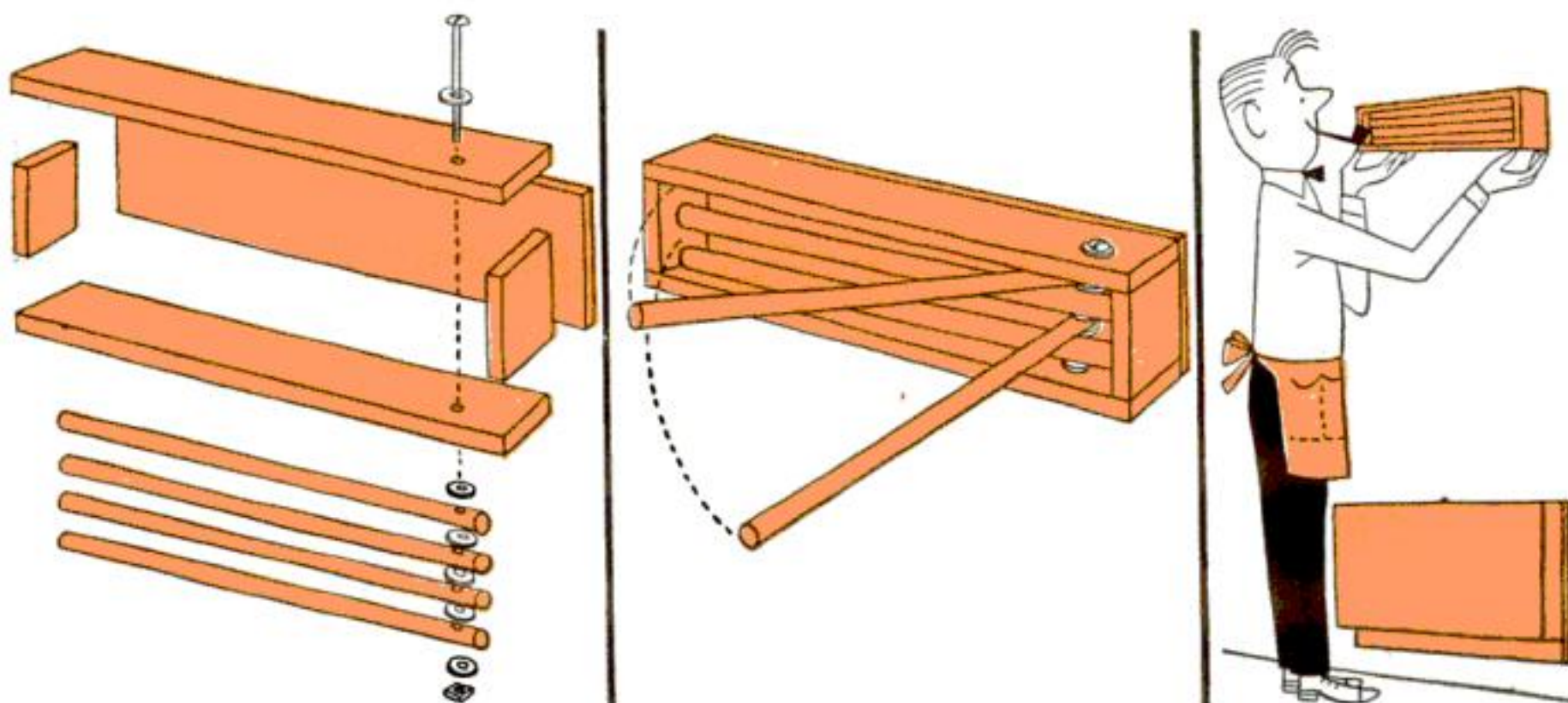
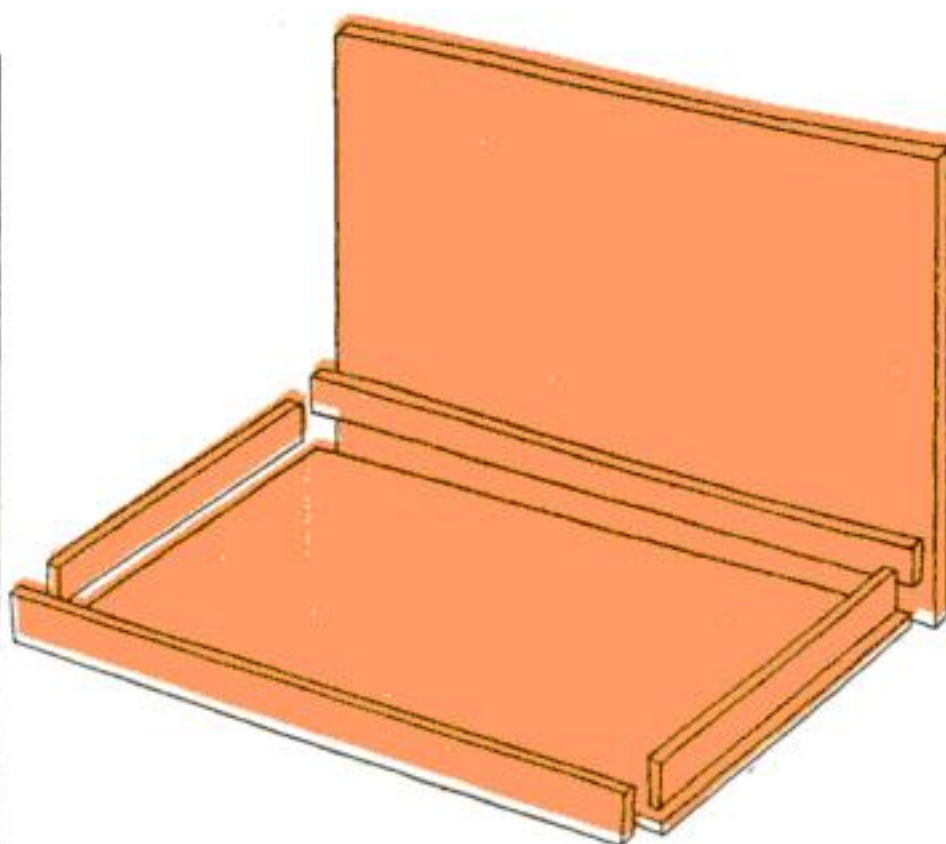
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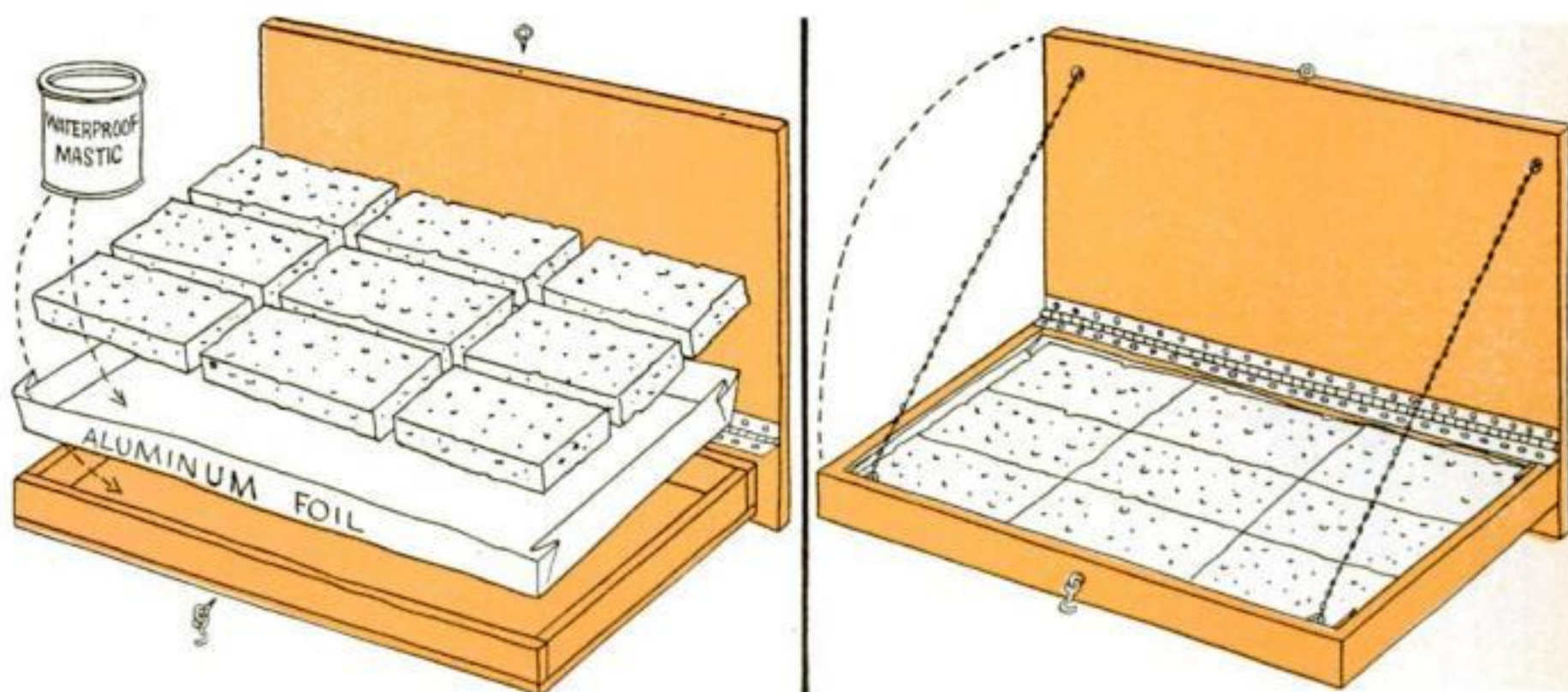
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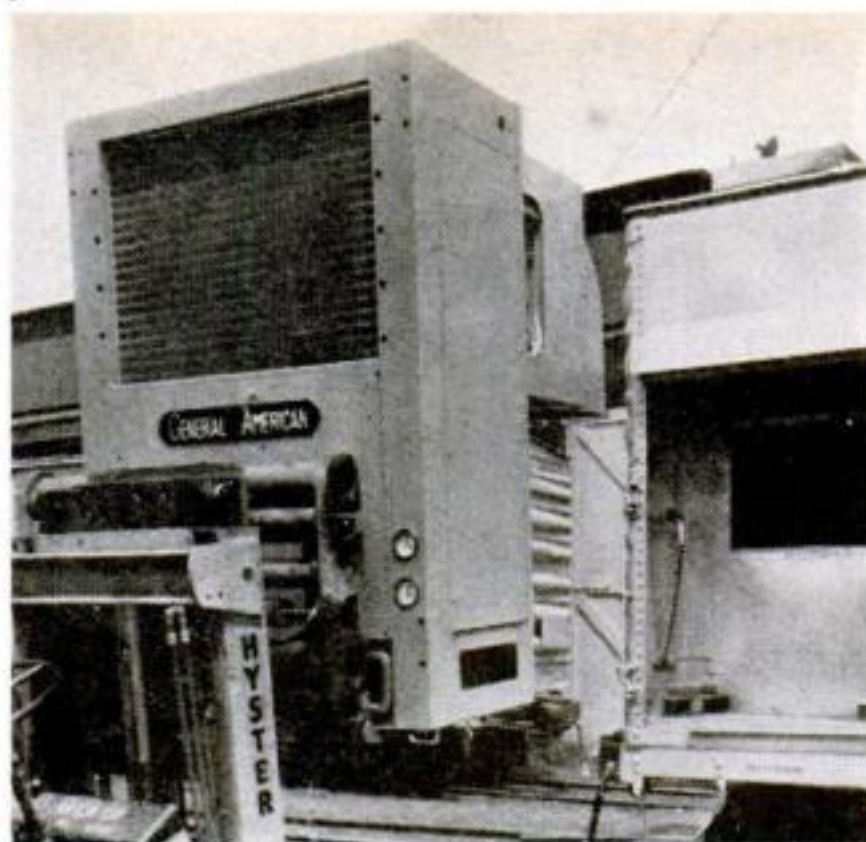
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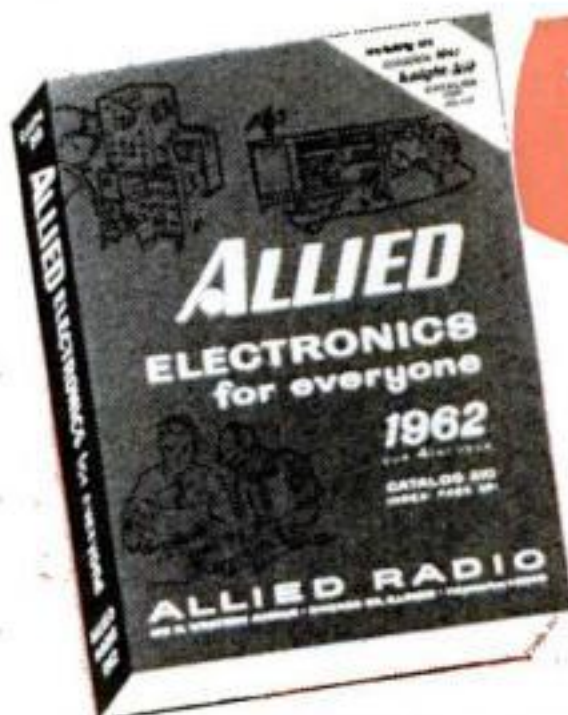
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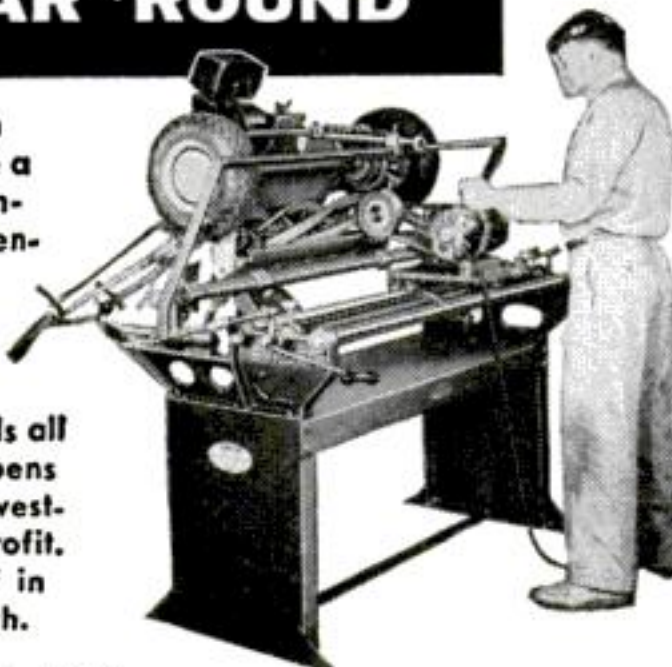
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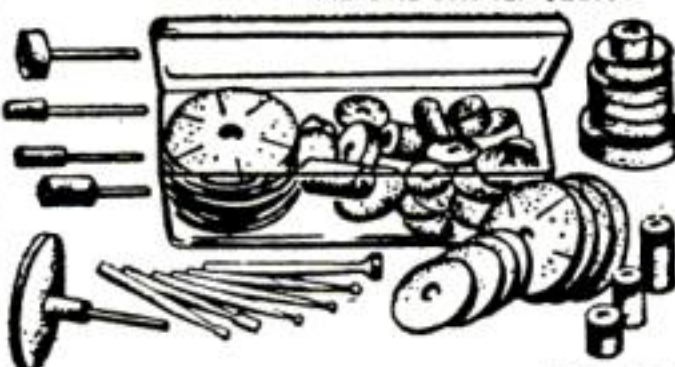
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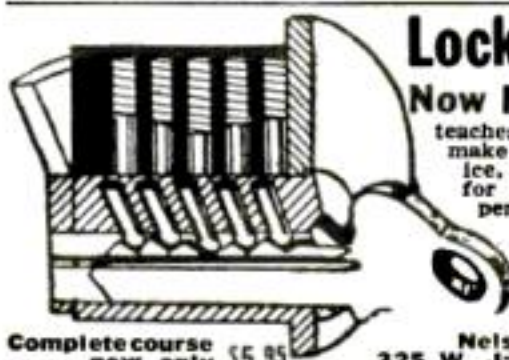
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Odd Jobs

How many of the occupations, trades, or professions listed below can you identify? Check your choice, then see answers at bottom of column.—*Samuel Cabot Jr.*

1. LAPIDARY

- a. Rabbit fancier
- b. Furrier
- c. Floor finisher
- d. Worker with gems

2. FLETCHER

- a. Arrow maker
- b. Skinner
- c. Porter
- d. Bacon cutter

3. DOFFER

- a. Novice golfer
- b. Bobbin changer
- c. Hat-factory worker
- d. Glovemaking

4. WAINWRIGHT

- a. Stockbroker
- b. Wagonmaker
- c. Boatbuilder
- d. Court secretary

5. JOINER

- a. Clubman
- b. Carpenter
- c. Devout churchgoer
- d. Seamstress

6. BONIFACE

- a. Bridegroom
- b. Monk
- c. Innkeeper
- d. Novice

7. SCRIVENER

- a. Street cleaner
- b. Chimney sweep
- c. Writer
- d. Rag dealer

8. VENIREMAN

- a. Juror
- b. Woman chaser
- c. Salesman
- d. Herald

9. FARRIER

- a. Grain harvester
- b. Horseshoer
- c. Dealer in skins
- d. Boat operator

10. PUDDLER

- a. Itinerant salesman
- b. Dog fancier
- c. Ironworker
- d. Water boy

11. TAPSTER

- a. Bartender
- b. Pottery tester
- c. Faucet repairer
- d. Tap-and-die maker

12. APIARIST

- a. Plagiariast
- b. Tailor
- c. Monkey-house keeper
- d. Beekeeper

13. TUCKPOINTER

- a. Shirtmaker
- b. Nail and tack maker
- c. Mortar-joint repairer
- d. Traffic director

14. HOROLOGIST

- a. Medical specialist
- b. Watchmaker
- c. Fortuneteller
- d. Horror-movie maker

15. PETERMAN

- a. Oil driller
- b. Fisherman
- c. Safe cracker
- d. Mountain climber

16. NUMISMATIST

- a. Coin collector
- b. Anesthetist
- c. Rock driller
- d. Hypnotist

17. FULLER

- a. Poker player
- b. Comedian
- c. Barrel filler
- d. Cloth thickener

18. REEVE

- a. Village official
- b. Rope maker
- c. Locksmith
- d. Loom tender

19. VINTNER

- a. Lay preacher
- b. Purchasing agent
- c. Herb grower
- d. Wine merchant

20. ACTUARY

- a. Notary public
- b. Insurance calculator
- c. Lie-detector expert
- d. Official weigher

1. d; 2. a; 3. b; 4. b; 5. b; 6. c; 7. c; 8. a; 9. b; 10. e; 11. a; 12. d; 13. c; 14. b; 15. c; 16. a; 17. d; 18. a; 19. d; 20. b

Not everyone does as well, but T. N. CODY, who started a business of his own, reports...

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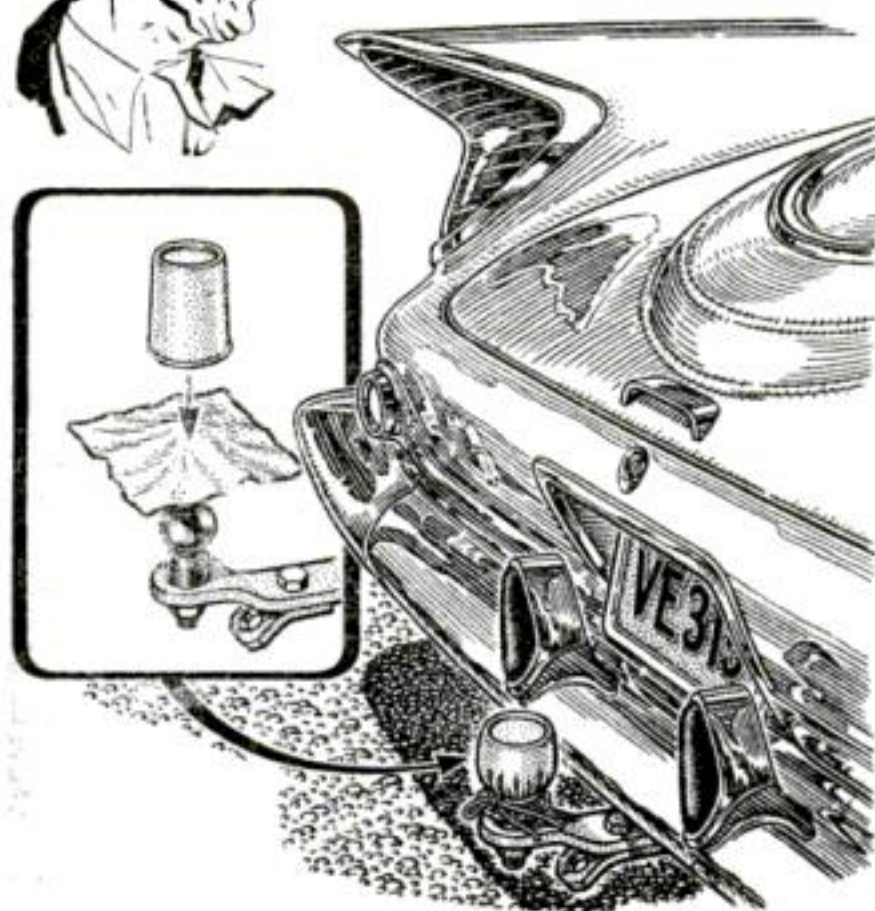
NAME _____

STREET _____

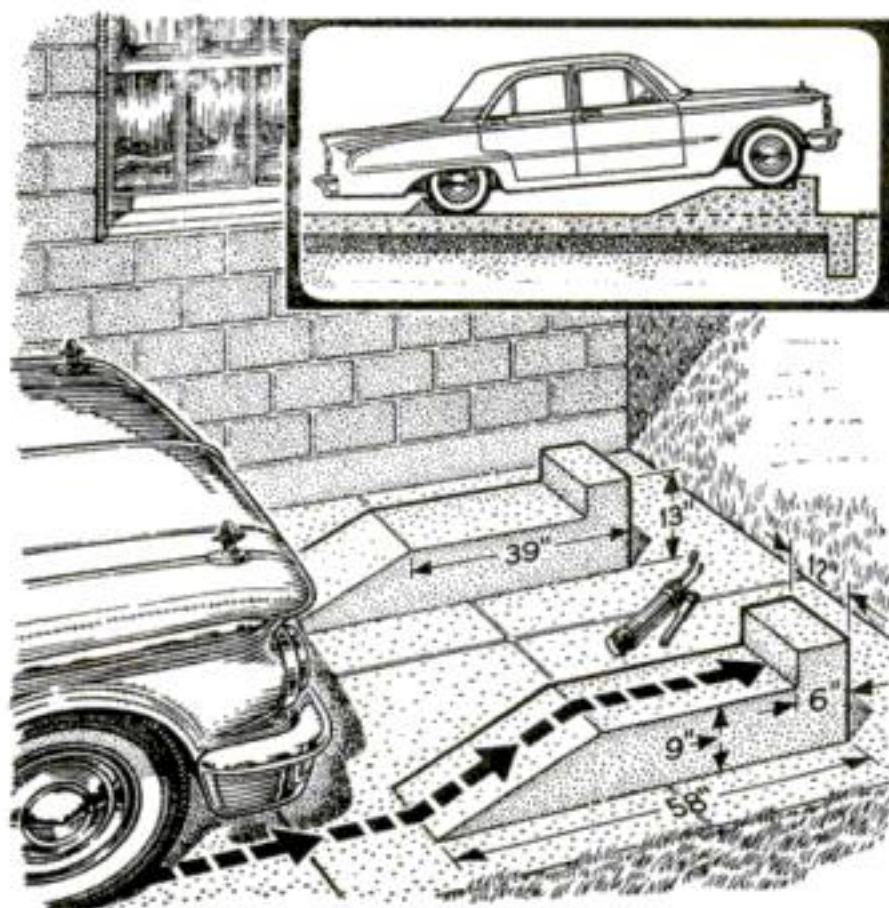
CITY _____ STATE _____



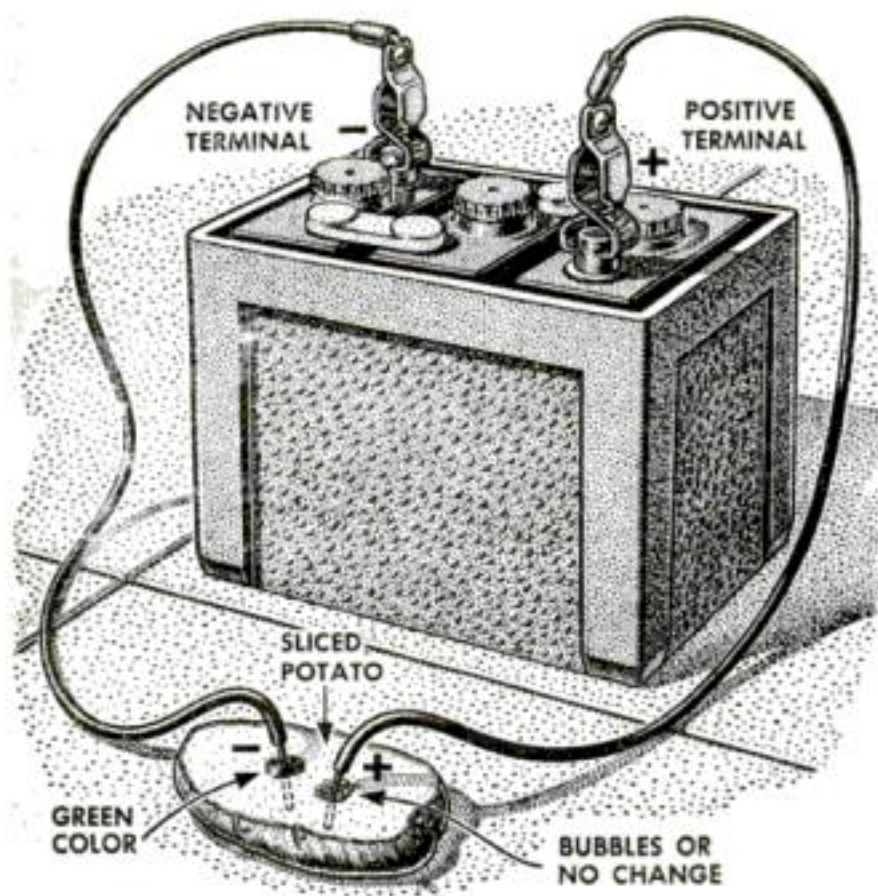
Hints from the Model Garage



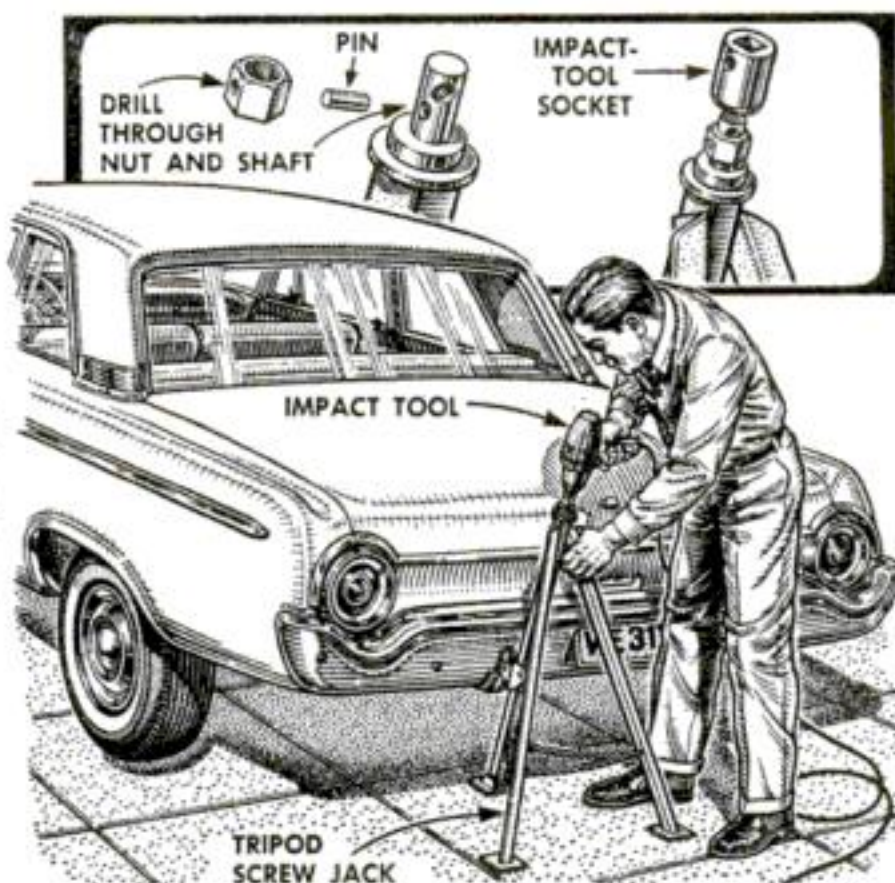
A trailer ball hitch won't rust while not in use if you place a few drops of heavy oil on it and cover it with a rag. Fold the rag to about four inches square. A wax-paper cup tied over the rag with strong cord gives extra protection.



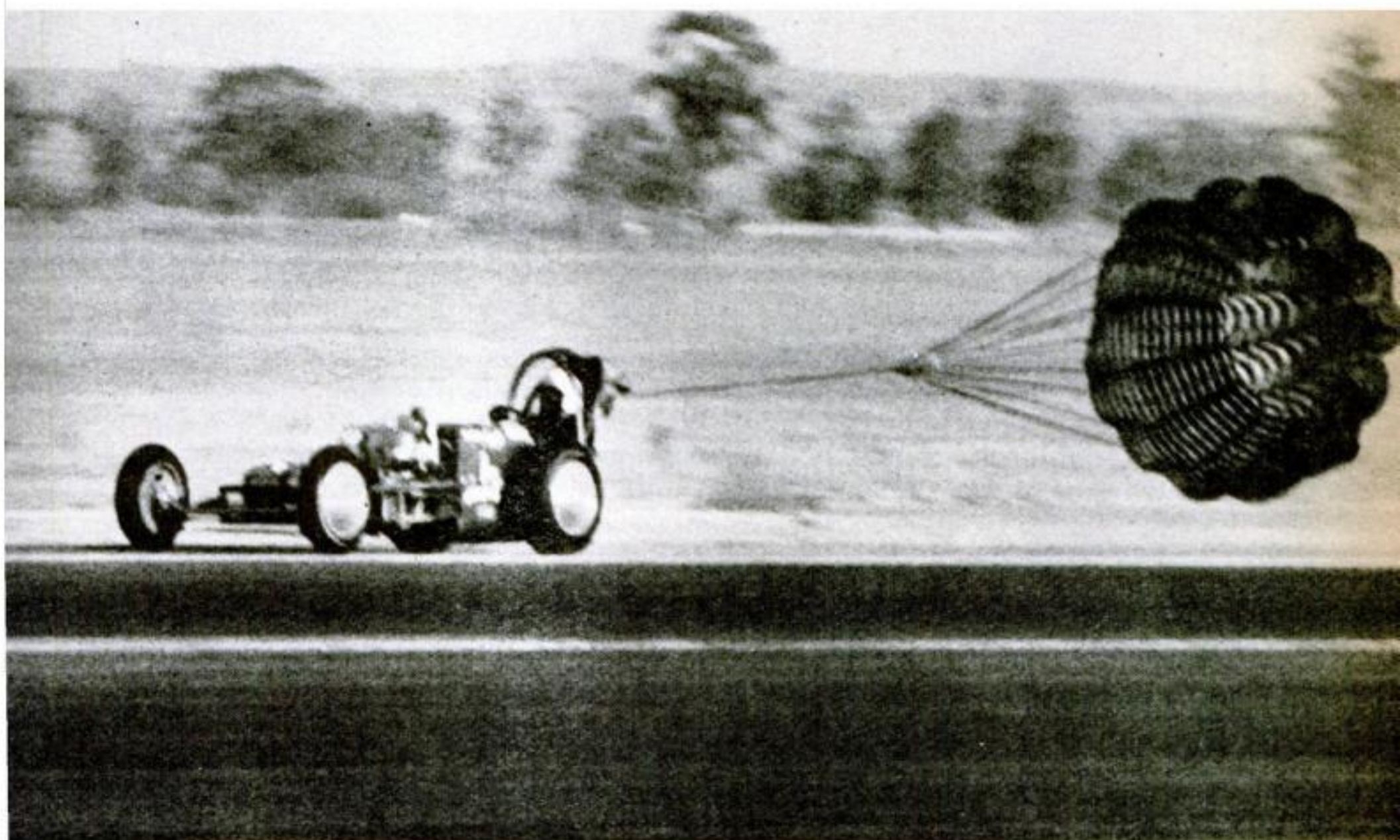
Two reinforced-concrete ramps built at any convenient spot will allow you to raise the front or rear of your car for home servicing and repairs. The car's track will determine ramp spacing. Use wheel chocks at opposite end for safety.



Which battery terminal is which? When corrosion obscures markings, half a potato can come to the rescue. Run leads from terminals into the potato, about an inch apart. Green color identifies negative lead. Positive lead may show bubbles.



Fast jacking with a power impact tool. Remove handle from a tripod jack and replace it with the largest nut the impact tool will accept. Drill through nut and jackshaft, secure with pin, file pin flush. Engage the impact tool and let 'er go.



Thompson pops his braking chute after a record run! His spark plugs: new silvery-plated Champions!

Mickey Thompson -- world's fastest driver -- set 14 new national and international records in one morning! Like winners of 9 out of 10 major races, he insists on Champion spark plugs...because Champions have no equal for performance! Why settle for less in your car?

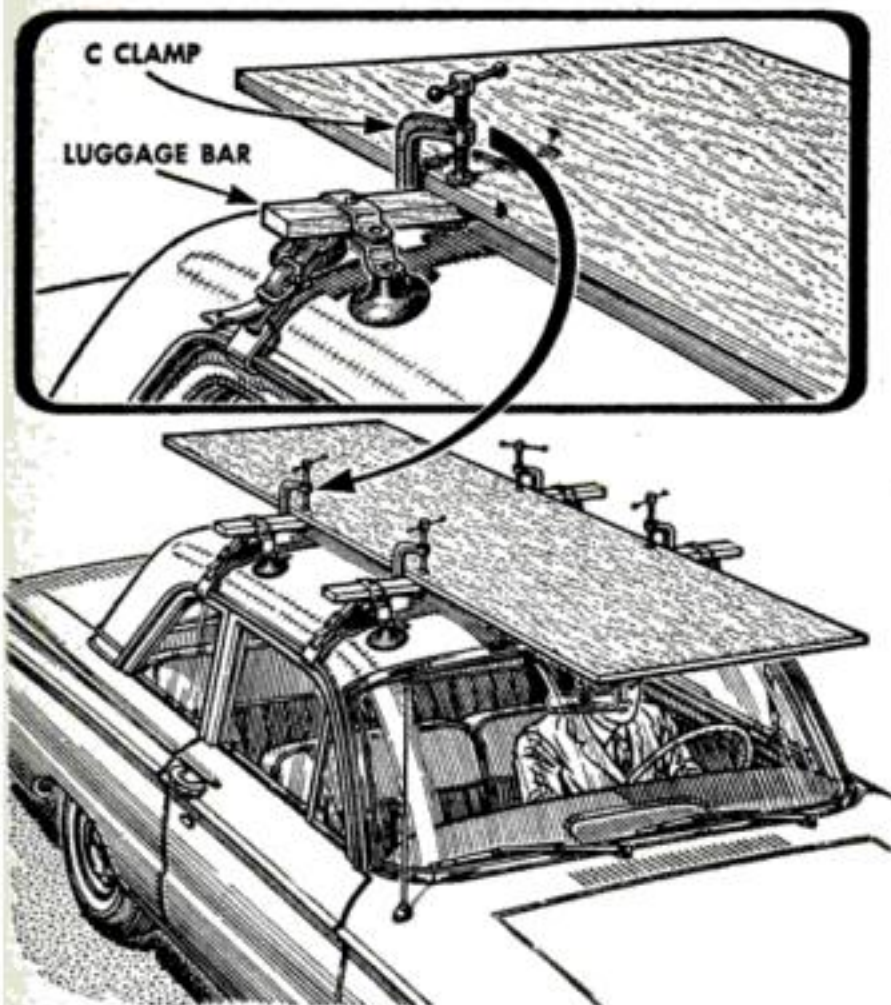


CHAMPION

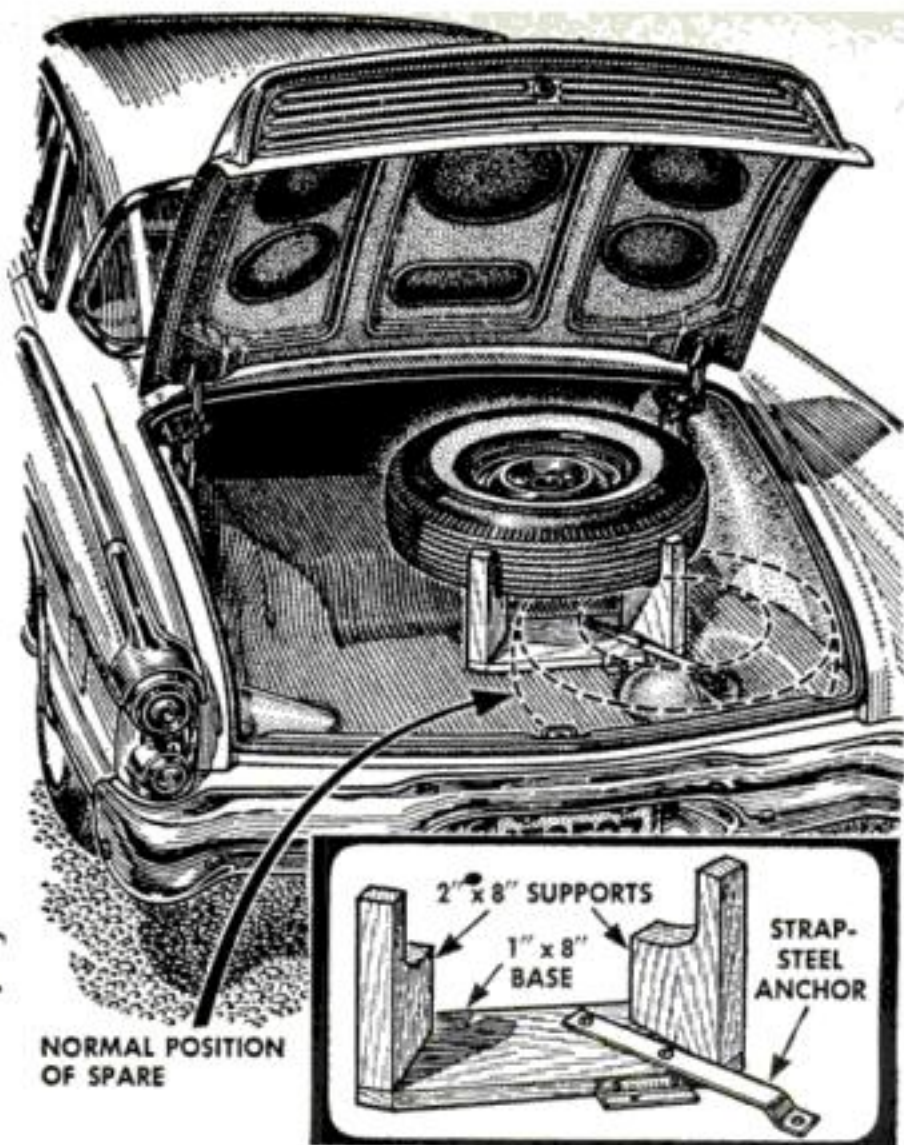


CHAMPION

More Hints from the Model Garage

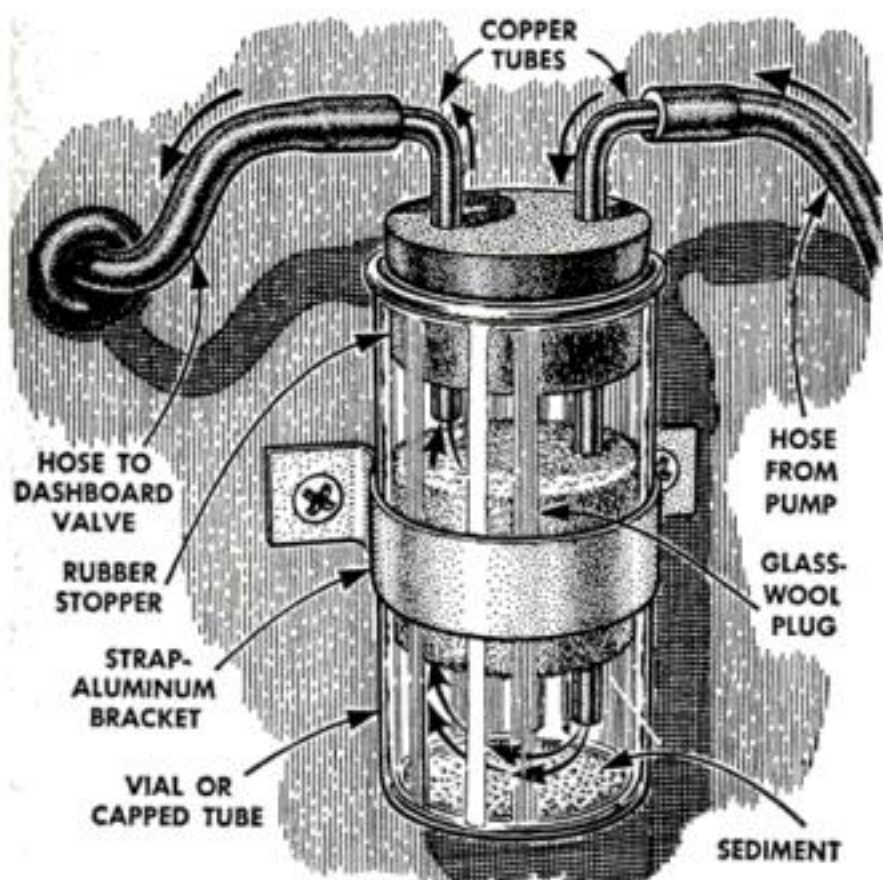


C clamps make car-top hauling easy, especially when you're carrying sheet materials such as plywood, fiberboard, or sheet rock. Clamping the cargo to the bars of the luggage carrier eliminates the need for securing with rope.

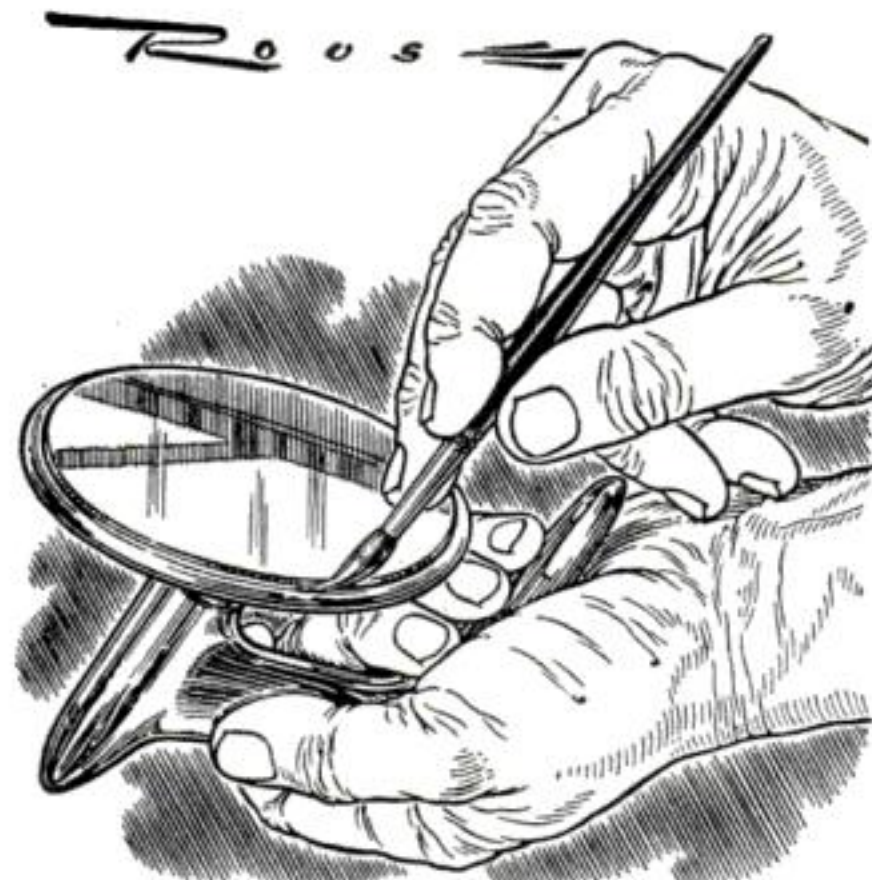


NORMAL POSITION OF SPARE

To increase luggage space, move your spare wheel from the trunk floor forward onto the shelf just behind the rear-seat cushion. Wood supports are easily cut with a jigsaw. No need to bolt down the wheel—it stays put even on rough roads.

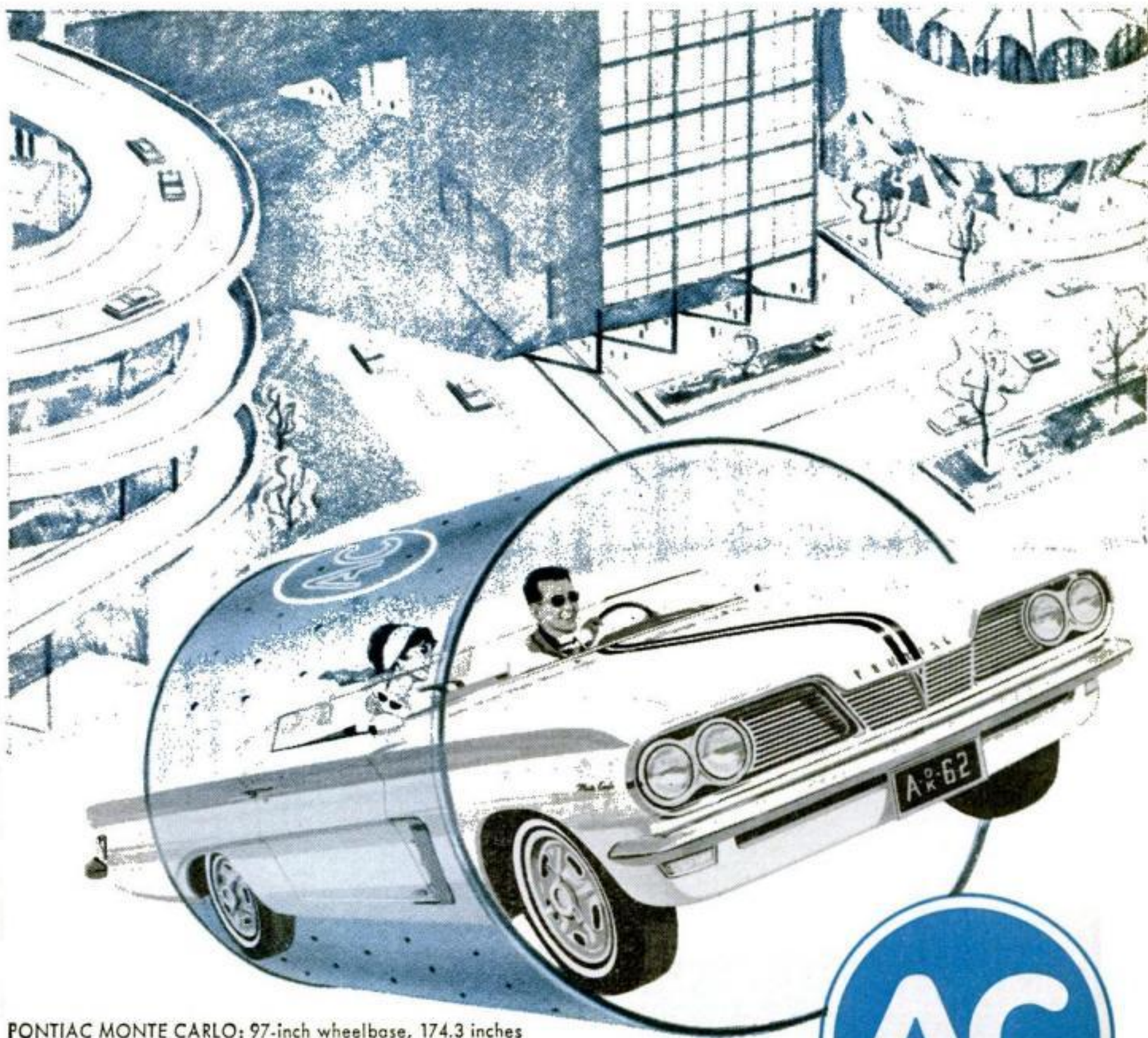


Windshield-washer clogging can be prevented with this homemade filter. Mounted in the water line between pump and dashboard valve, the four-inch vial or capped brass tube catches sediment. A glass-wool plug gives added filtration.



Side-view mirrors last longer if a thin line of clear lacquer is painted around the edge of the glass where it meets the metal. This keeps moisture from getting behind the glass and also helps prevent the mirror from loosening and rattling.

Like a breath of tomorrow



PONTIAC MONTE CARLO: 97-inch wheelbase, 174.3 inches over-all; 4-cylinder Tempest engine; 194.5-cubic-inch displacement; 8.25 to 1 compression ratio; Supercharger is positive displacement blower; 300 h.p. at 5600 r.p.m.

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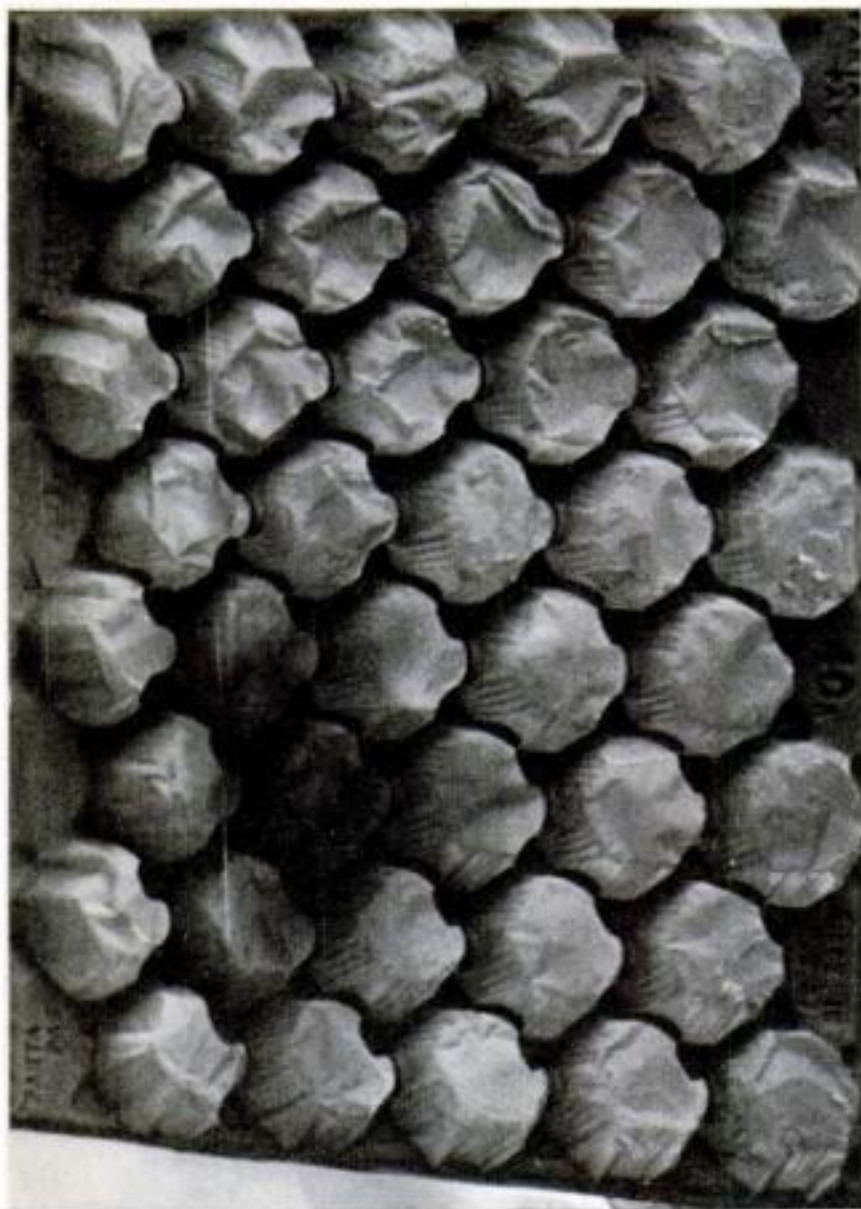
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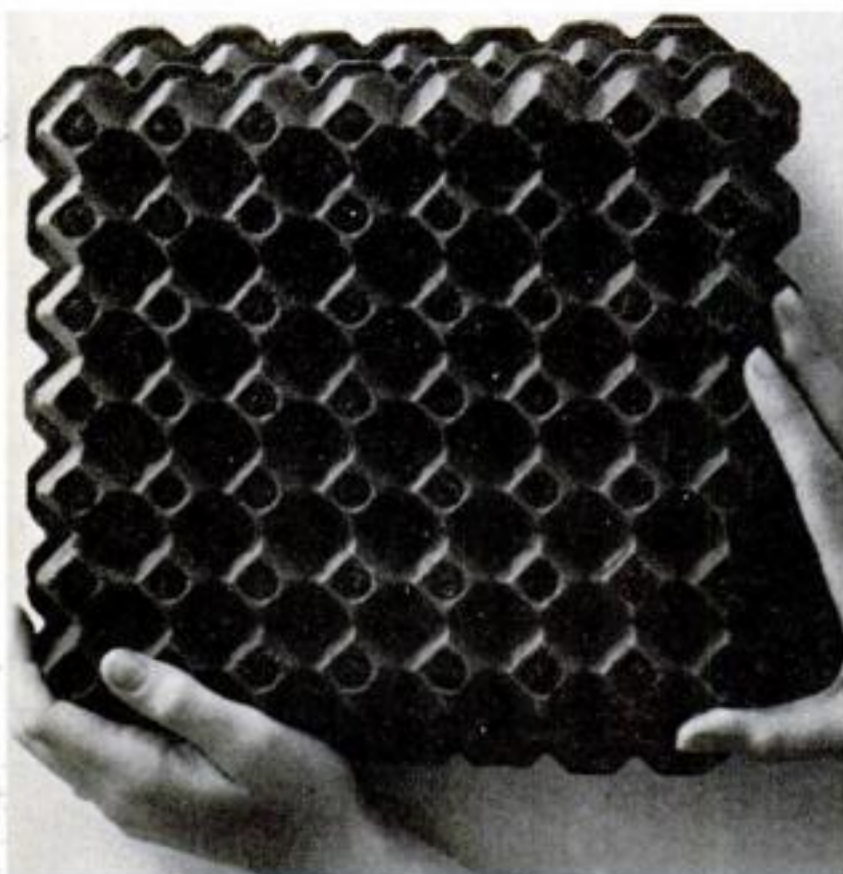
Can You Guess What These Things Are?



1. ☐ Wasps' nest
☐ Fruit tray
☐ Padded cell wall
☐ Soundproofing



2. ☐ Cookie jars
☐ Glass oil drums
☐ Leyden jars
☐ Highball glasses



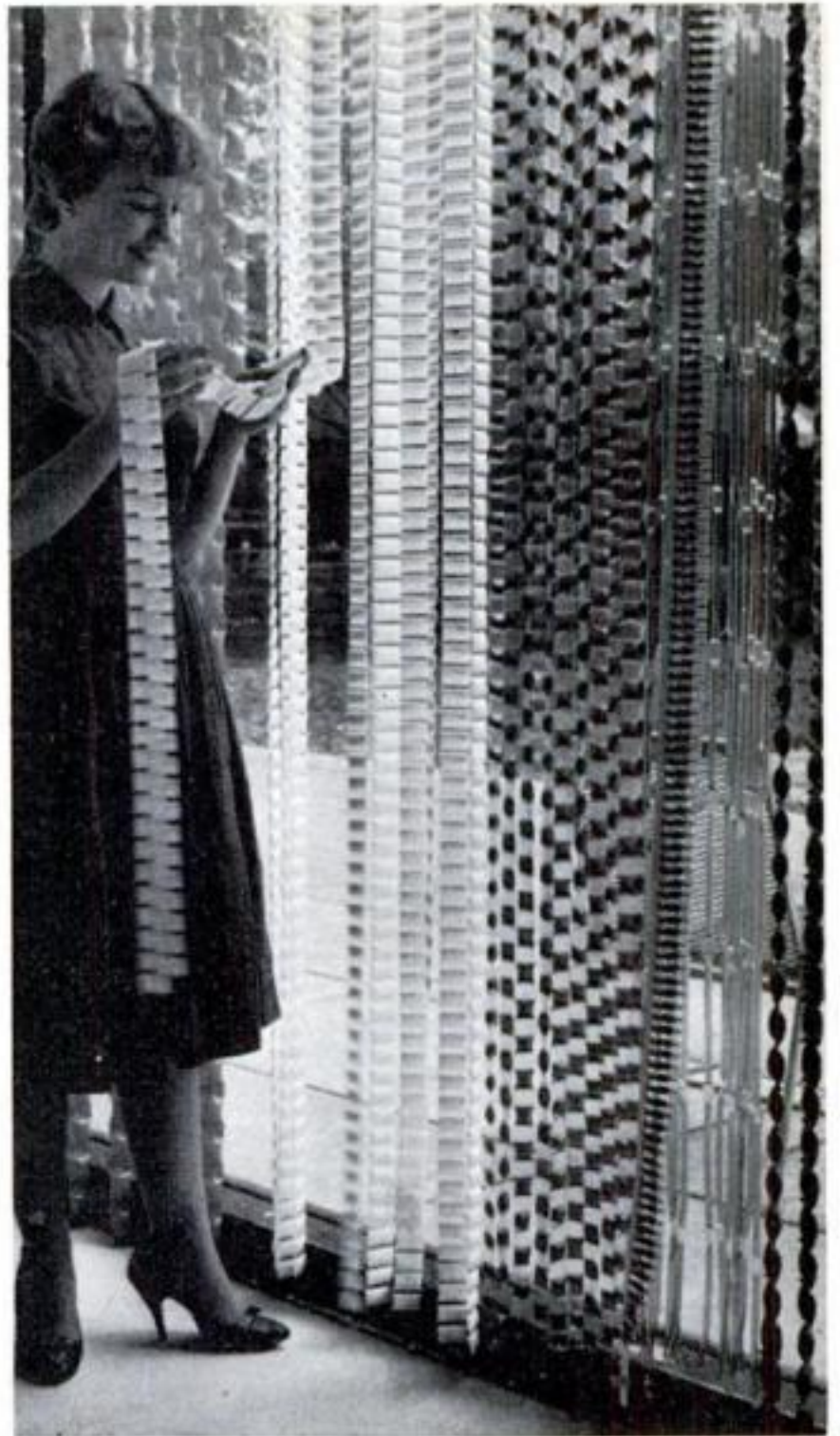
5. ☐ Beehive section
☐ Chinese checkers
☐ Door mat
☐ Briquette box



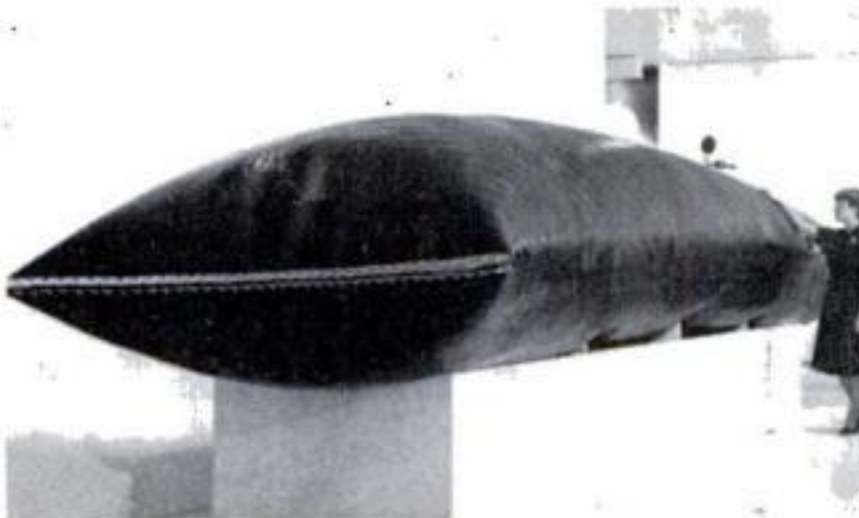
6. ☐ Play house
☐ Animal trap
☐ Labyrinth
☐ Disposable shelter



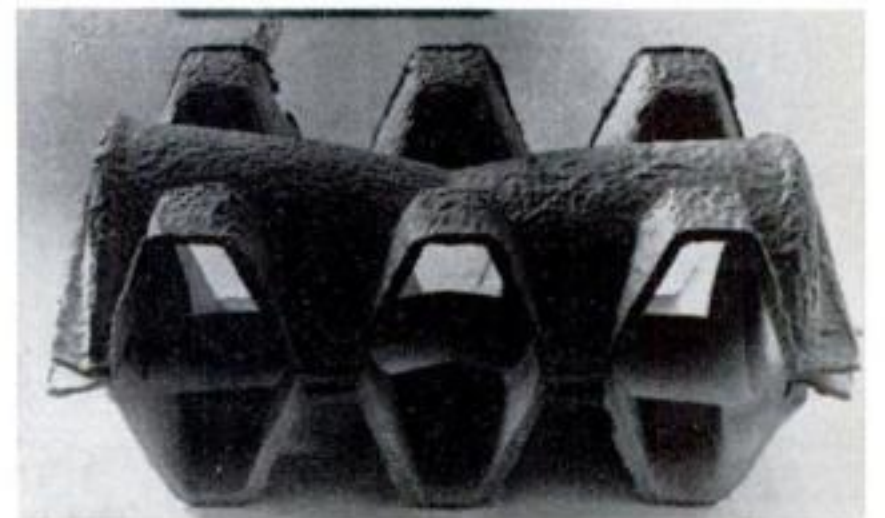
3. ☐ Christmas stocking ☐ Grain bag
☐ Boat sail ☐ Tapestry



4. ☐ Drapes ☐ Beads
☐ Synthetic seaweed ☐ Plastic containers



7. ☐ Toothpaste tube ☐ Collapsible tank
☐ Stuffed whale ☐ Collision mat



8. ☐ African mask ☐ Machine packing
☐ Play equipment ☐ Wood carving

All done? Now check your answers below

New York. Here's what they are: 1. Fruit tray, bottom view. 2. Glass oil drums. 3. Grain bag. 4. Plastic containers, in strips. 5. Briquette box. 6. Disposable shelter. 7. Collapsible tank. 8. Machine packing.

The eight objects in the quiz have one thing in common—all are containers. They were selected by judges as the most esthetically pleasing in a display of commercial packaging at the Museum of Modern Art in

DETROIT REPORT

S-P Brings Out Rival for T-Bird

STUDEBAKER-PACKARD plans to introduce a sporty new car several days after this issue of PS hits the stands. Insiders describe it as a cross between the Ford Thunderbird and the Chevrolet Corvette—a four-passenger car with reinforced fiber-glass body.

The builder of the new S-P car's body (Molded Fiber Glass Co.) also makes body panels for the Corvette. But unlike the Corvette body, which is shipped in panels to the Chevrolet plant in St. Louis, the S-P body will be delivered to South Bend completely assembled. There it will be fitted to a chassis probably similar to that of the new Studebaker Daytona sports model.

The original goal was a car much cheaper than the Thunderbird. But S-P is reportedly hanging on so many extras that this goal may not be realized.

Production of 5,000-10,000 units a year is expected.

Cool Cardinal. Most startling feature of the Ford Cardinal (to be unveiled next fall) will be its cooling system. Although liquid-cooled, the engine will not have a conventional fan in front.

Ordinarily, cooling will be taken care of by outside air rammed through the radiator while the car is moving. If the coolant should get too hot during idling or in heavy stop-and-go traffic, a thermostat will turn on an electric fan. A small auxiliary radiator—mounted in an out-of-the-way spot such as a fender well or, even more likely, in front of the firewall—also will cut in automatically to help dissipate heat.

Besides saving 5-10 hp. at 60 m.p.h. and increasing gas mileage, this setup will leave extra space in the engine compartment. The space is particularly valuable in the Cardinal, as its snout is already crowded with front-wheel-drive components.

During cold weather the small radiator and electric fan will also serve as a passenger-compartment heater.

Though numerous changes have been made in the Cardinal, engineers have stuck to their original engine—a V-4 that looks like half a V-8.

People who have driven the Cardinal rave about its fine handling.

No more Dynaflo. The 1963 Buick will offer as standard equipment the Roto Hydra-Matic transmission now used by Oldsmobile and Pontiac, according to a

reliable source at GM's Transmission Division. Chevrolet set the trend this year by dropping its version of the smooth but expensive turbine-drive transmission.

Another new Chevrolet engine. In a few months the Chevy II will add a small, all-new V-8 to its list of engine

options. This will make it the only domestic car going to market in four-, six-, and eight-cylinder versions.

Safer directionals coming. Amber turn signals at the front will be standard on all American cars next year. Engi-

neers say that amber signals offer better visibility under glare conditions and at night when used with headlights.

Ford "1962½" line. "Putting the fun back into driving" is Ford's goal in bringing out sporty versions of the Fairlane, Falcon, and Galaxie this spring. The 221-inch Fairlane V-8, no slowpoke,

will be bored to 260 inches. A British-built all-synchro four-speed gearbox, same as on the British Zephyr, will be optional for Falcon. All will boast bucket seats, consoles, and carpeting.



SELF-SCRUBBER

WHAT YOU SHOULD KNOW ABOUT THE SPARK PLUG THAT CLEANS ITSELF WHILE YOU DRIVE.

First off, it cleans itself with the heat of your engine. Autolite Power Tip spark plugs extend a bit deeper into your combustion chamber. Not much deeper. Just enough so that potentially

harmful deposits get little chance to accumulate. They're burned right up and out the tailpipe. That's why your Autolite spark plugs stay cleaner.

That is why your car runs better. That is also why you don't have to buy so much gasoline.

One other point you should know about the

spark plug that cleans itself while you drive. Ford Motor Company now installs Autolite Power Tip spark plugs as original equipment on every new car it builds. Other manufacturers use them too.

Next time you change spark plugs, stick in some self-scrubbers . . . some Autolite spark plugs.

SPARK PLUGS • BATTERIES • SERVICE PARTS
 **AUTOLITE**
 THE NAME TO REMEMBER WHEN YOU CARE FOR YOUR CAR

HOME SHOP

news report

By Sheldon M. Gallager

The mail-order catalogue: a fine shop encyclopedia. I've just finished thumbing through the big new Sears, Roebuck and Montgomery Ward catalogues for '62 and am struck again by what a handy source of day-to-day shop information they can be. Often running to 1,500 pages, these mammoth volumes are actually a combination reference library, encyclopedia, and engineering handbook all rolled into one.

Have a problem? They'll help you solve it. Let's say you want to add a new bathroom, hook up a darkroom sink, or pipe water to a basement bar. Under Plumbing you'll find diagrams showing a complete home drainage system, tips on working with plastic pipe and copper tubing. Or maybe you're insulating an attic. Here, in sketches, are four basic methods, depending on how the attic space is to be used, plus handy tables for estimating how much insulation you'll need and what it will cost.

As a general reference guide, mail-order catalogues offer such fascinating bits of information as how to use a soil injector to get rid of termites (by poisoning the earth around your home), and how long it will take you to water your lawn (with a 1/2"-diameter hose, about 5 1/4 hours for each inch of water per 5,000 square feet). If you need a well pump, but aren't quite sure what size, a special chart tells you just how many gallons per hour you can expect from each type, depending on how far down the water is.

The designer's bible. In planning furniture, built-ins, or other projects, it's often helpful to know typical dimensions, how other builders have solved certain problems. How do you build a kitchen corner cabinet without wasting the corner space? How high is a highboy? Adding a room or porch? You'll find useful listings of stock window, screen, and door sizes, railings, columns, and wall panelings so you can make the job easier by designing it to make use of readily available materials.

How can you get the catalogues? Since these big books are expensive (actually almost \$2 a copy), both companies like their catalogue users to make at least a few small purchases a year to cover the cost. A minimum of two orders totaling \$15 from each six-month Sears or Monty Ward catalogue will put you on the mailing list to receive new catalogues.

Easier ripping on a radial-arm saw. Rockwell Mfg. Co., maker of Delta power tools, passes along these three tips for improving rip cuts on a radial saw:

1. Cover the table with a sheet of hardboard to keep sliding stock from stubbing its toe on the rough score marks made by the blade. Cleats at the edges of the hardboard drop over the sides of the table to hold the board in place.

2. To keep fingers away from the blade, mount the fence at the



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up
when the
mowing gets
tough!



When the grass is thick and heavy, the weeds are tall and tough, Gravely gives you the lugging power—the performance—to get the job done . . . right! No pushing, pulling or pampering needed—Gravely POWER does the work!

You ride for the routine jobs, guide for the tough jobs. Have a flexibility of performance, a versatility of tools that will make your place the envy of the neighbors, a source of pride and satisfaction to yourself, without drudgery!

30 TOOLS from which to choose, powered by the one 6.6 hp Gravely Tractor. All-Gear Drive, two speeds forward and reverse . . . designed and built for the tough jobs. Optional electric starter.

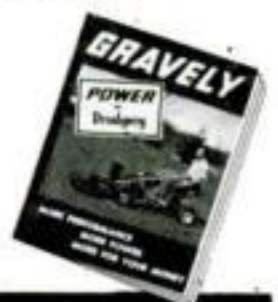
Installment Plan Available

Get the facts before you buy—from Gravely's big 24-page "Power Vs. Drudgery" booklet. See how Gravely proves it's best for you before you buy! Write now!



GRAVELY TRACTORS

DIVISION STUDEBAKER-PACKARD CORPORATION
P. O. BOX 602-D
DUNBAR, W. VA.



Sold & Serviced by Authorized *GRAVELY* DEALERS—our 40th year!

Home shop news report continued

front of the table and make a pusher to slide along it. Rabbet a scrap block at one end and tack a strip of hardboard across the open end of the rabbet. This forms a U-shaped channel to hook over the fence and push the work safely.

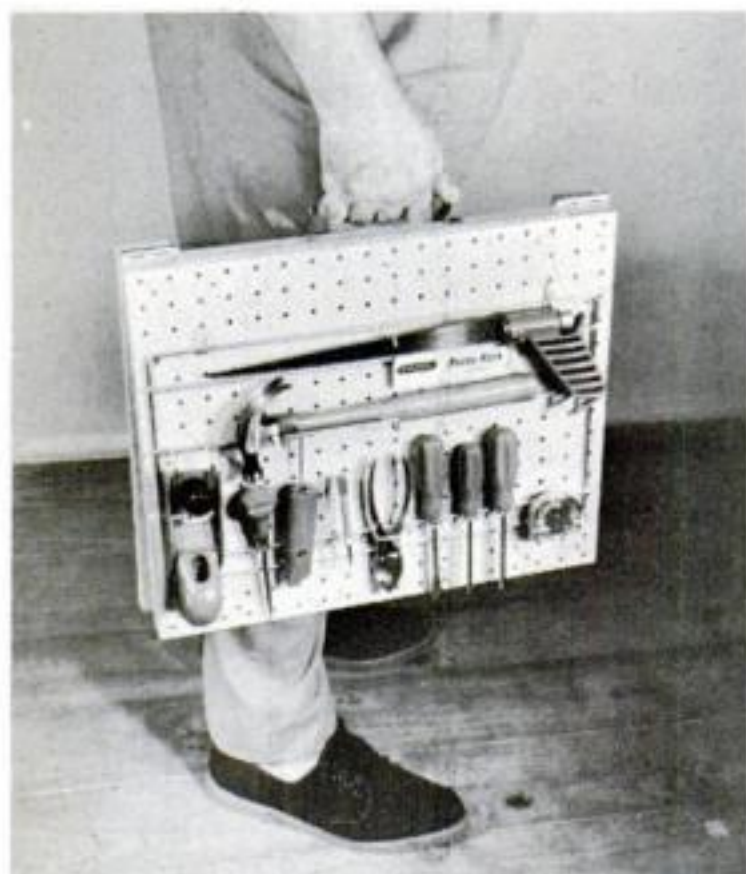
3. For accurate shaping or dadoing of narrow strips, feed them through a U-shaped channel turned upside down to form a snug-fitting tunnel. Make the channel 6" to 8" long, then cut it in two and clamp the halves to the fence, one on each side of the blade.

Quick way to make a sawhorse. Take a length of two-by-four or two-by-six, clamp on a pair of new folding aluminum legs, and you have a sawhorse—that easily. For storing or carrying, the A-frame legs can be collapsed flat. Besides horses, they make a nifty outboard-motor stand or supports for scaffolds and tables. They're 24" high and can be raised to 30" with extensions. A set of four (for two sawhorses) sells for about \$10 from Trojan Products Corp., 1131 E. 25th St., Indianapolis, Ind.

Want help in pruning? Here's a handy guide. How do you know when to prune a bush, a tree, a hedge? The famous Disston saw people have come to the rescue with a fine little pruning guide that tells you not only when, but how and what tools to use for each. It's available for 25 cents from Disston Div., H. K. Porter Co., Inc., Pittsburgh.

Electronics afloat: a new book tells all. Said to be the first of its kind, a fine new book tells you how to buy and use all types of electronic gear for small pleasure boats. Entitled "Electronic Equipment Made Easy for the Boat Owner," it covers navigating aids, depth sounders, direction finders, and other instruments as well as boat wiring, power requirements, and emergency repairs at sea. Its author is John D. Lenk, an ex-Navy electronics expert. Price is \$5.95 from John F. Rider Publisher, Inc., 116 W. 14th St., NYC.

Tip of the month: a totter for tools. Look what you can do with a scrap of perforated hardboard (left). Tacked to a light wood frame, it becomes a handy portable rack for carrying your tools to the job. Two legs, hinged at the top, swing out in back to hold it upright, easel-fashion. A nice touch: The one pictured here was designed by George Daniels of Danbury, Conn., to take Stanley's new 11-tool wall rack. It's made to hook into perforated board and sell, complete with tools, for \$16.50 by Stanley Tools, 111 Elm St., New Britain, Conn.



Lose that special key? Those special, hard-to-find keys that keep getting lost—for clocks, skates, radiators, pianos, valves, and the like—can be replaced from a special assortment put out by Taylor Lock Co., Philadelphia 32. You'll find them on display racks in hardware stores.



KEEP YOUR CHEVY the CHEVY-EST* with *Genuine* GM Chevrolet cooling system replacement parts

Say it's a vital cooling system part you need, such as a water pump. Or simply a radiator hose. The important thing is to make sure you get the same quality that was originally built into your Chevrolet part by part. That means *genuine* GM Chevrolet parts. They're engineered especially for your car, so you know they'll fit right the first time—an important advantage, whether you do the installation yourself or have it done. And they're durably built to Chevrolet's quality-controlled specifications to give you long trouble-free service. You'll find them available at your local Chevrolet dealer's or through leading independent garages and service stations. Ask for them by name.... Chevrolet Division of General Motors, Detroit 2, Michigan.



**Chevy-est: all Chevy with new-car reliability maintained part by part.*



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cigarette
means
a lot...

you get lots more from **L&M**

more body
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more taste
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It's the rich-flavor leaf among L&M's choice tobaccos that makes every puff heartier—for full pleasure. L&M has more of this longer-aged, extra-cured leaf than even some unfiltered cigarettes. And with L&M's modern filter—the Miracle Tip—only pure white touches your lips. L&M, in pack or box—the filter cigarette for people who really like to smoke.

EVER since Chevrolet introduced its unadorned compact, the rear-engine Corvair, back in 1959, the company has popped up with one thing after another to put it in snootier company. First it added bucket seats and laid on more chrome. Then it booted up the power by 22 horses. Then it added a four-speed transmission.

Last month Chevy confessed that it had been up to something more. It brought out a Corvair bomb. The small, pancake, air-cooled engine sported a supercharger. Out of a sparse 145 cubic inches of piston displacement roared 150 horsepower.

Chevy had converted the Corvair into a sort of vest-pocket Corvette, America's only sports car.

The reworked engine was notable on other counts:

- It was the first U.S. production passenger-car engine in history fitted with a turbine-driven supercharger.
- It ballooned the top speed of the

**New
turbocharger
makes
Corvair**

**150
Horses
Hot**

By Devon Francis



Tidy turbocharger delivers more than one horsepower for each cubic inch of piston displacement



SIMPLICITY OF TURBOCHARGER is shown by exploded components and (at right) semischematic cutaway. Pump is centrifugal type. Engine produces 1.03 hp. per cubic inch. When turbocharger operates, cylinder temperatures go up as much as 300 degrees beyond those of regular Corvair engines. Dash gauge is "red-lined" at 600 degrees to indicate malfunction. Top crankshaft r.p.m. is boosted to 5,200 compared with 4,400 for the regular 80- and 102-hp. engines.

Corvair from 88 to 115 miles an hour.

• Used sensibly, it was economical of fuel—in contrast to the piggish characteristics of most supercharged engines.

The Corvair turbocharger, as Chevy prefers to call its supercharger, produces all that extra power by ramming more air (and more fuel) into the cylinders.

But it bleeds no power from the engine for its own rotation, as belt- or gear-driven superchargers do. In essence, it is a shaft with a turbine on one end and a compressor—a pump—on the other. The turbine sits in the exhaust stream, whirling from the force of the burned gases. As it whirls it turns the compressor. The compressor packs that added air and fuel into the cylinders.

How new is it? The idea is new, of course, only in this particular application. Trucks and earth-moving machinery have long used turbine superchargers. In

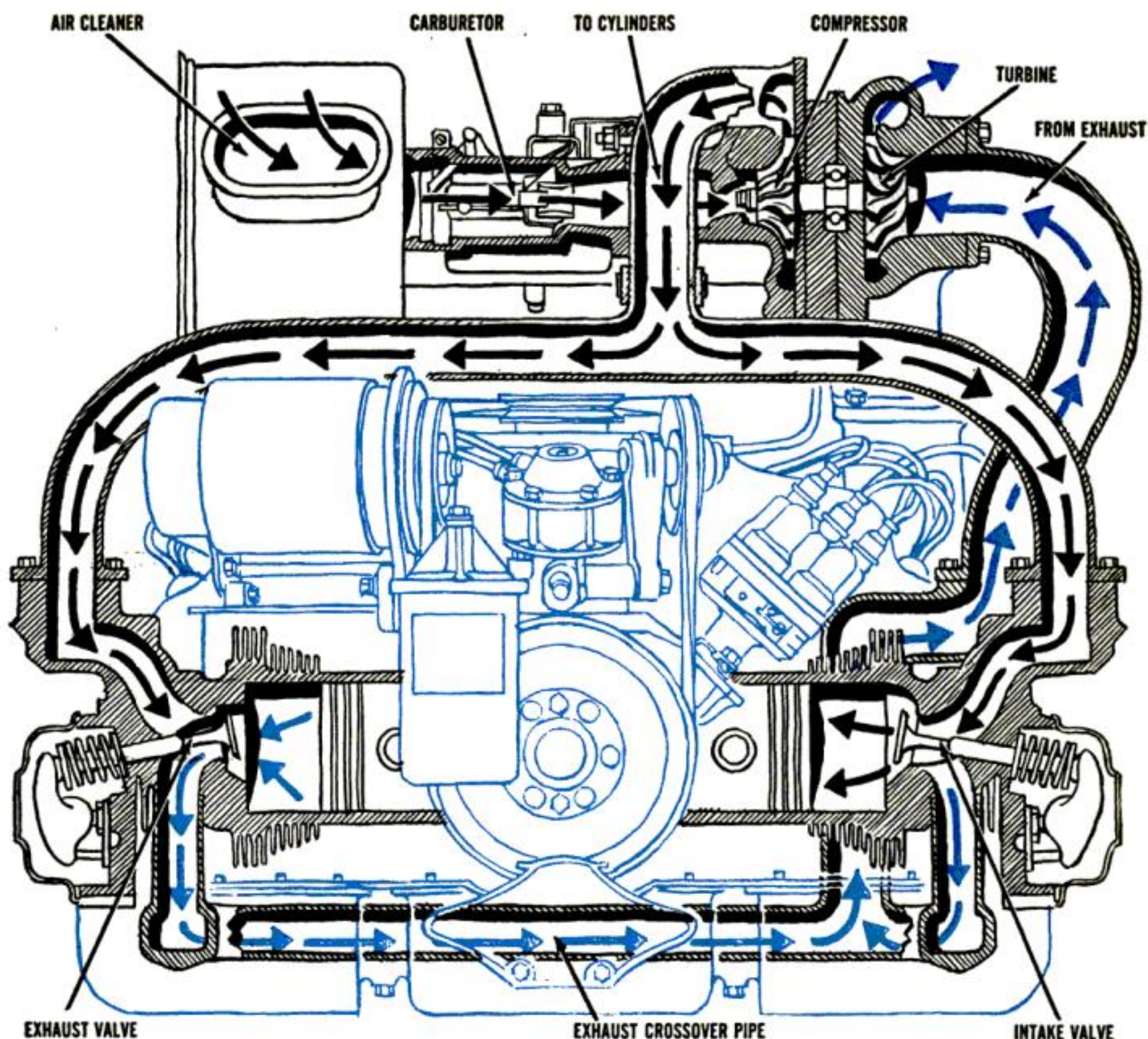
the heyday of the airplane piston engine, exhaust turbines were used for supercharging at high altitude.

As a passenger-car power booster, the Corvair turbocharger is impressive. It appears to respond instantly to the accelerator. It produces that 150 hp. from an engine originally rated at a mere 80. It produces 210 pounds-feet of torque against an original output of only 128.

How does the car do on the road? How does it compare with the 80- and 102-hp. Corvair engines? I tested the car for **POPULAR SCIENCE** and got these performance figures (in seconds):

| | 80 HP. | 102 HP. | 150 HP. |
|--------------|--------|---------|---------|
| 0-60 M.P.H. | 23.2 | 16.8 | 9.7 |
| 0-80 M.P.H. | 64.1 | 31.6 | 18.5 |
| 40-80 M.P.H. | 53.8 | 21.6 | 10 |

That's fast. At 0-60, the supercharged Corvair comes within 3.8 seconds of the huskiest of the Corvettes.



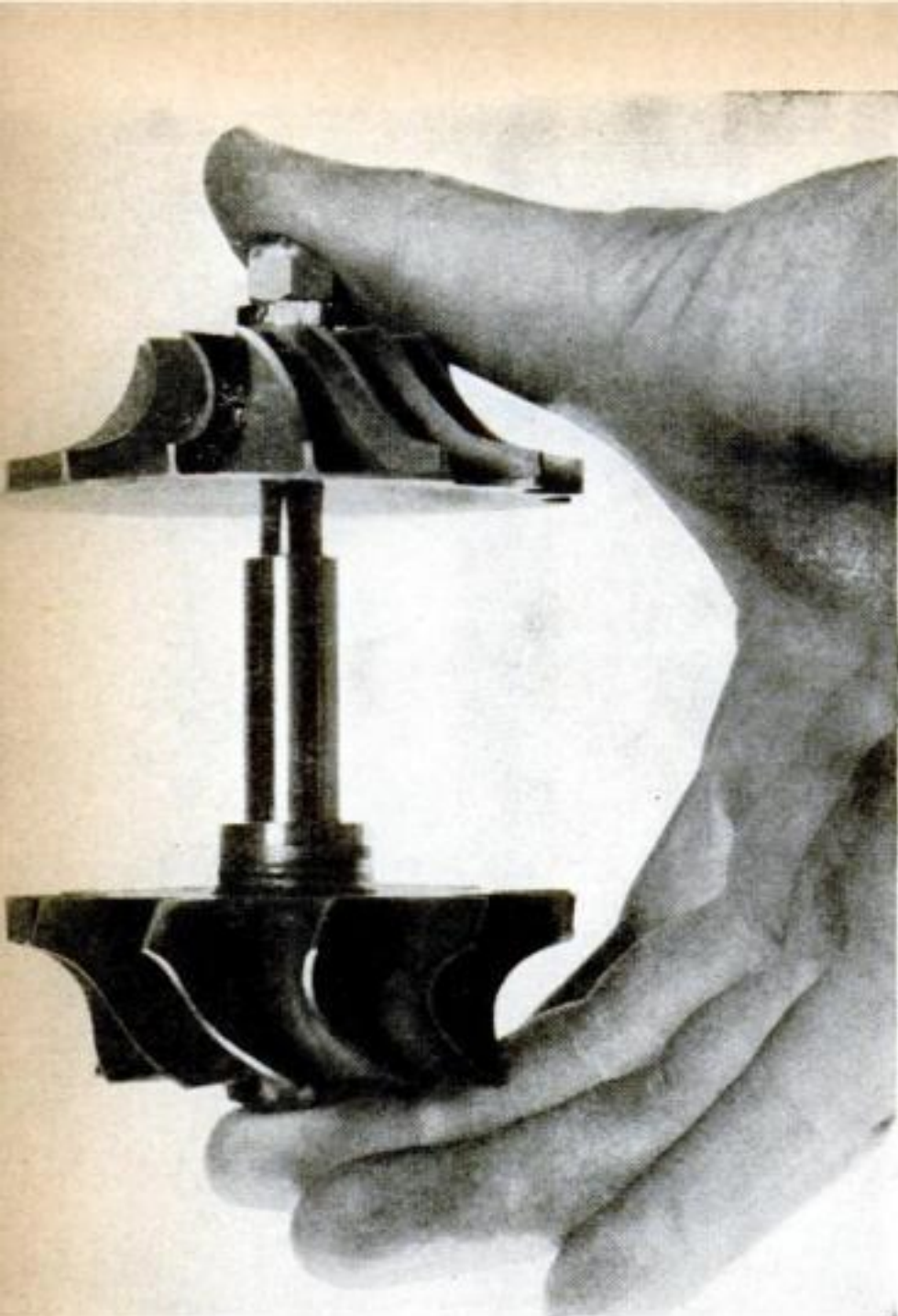
Spinning at 70,000 r.p.m. The turbo-charger has another fetching—indeed, most important—characteristic besides demanding no engine power for its operation. It begins boosting the power (at turbine-pump speeds up to 70,000 r.p.m.) only when pressure on the accelerator calls for it. The rest of the time the turbine freewheels in the exhaust stream. To see why that's so, take a look at how it works:

The main parts of the system, besides the turbine wheel and pump wheel, are a special side-draft carburetor, ductwork for routing the exhaust gases past the turbine, an induction crossover tube to distribute the supercharged air-gas mixture to manifolds on each side of the flat engine, and a system for retarding the spark in that range of engine speed where knocking could occur.

The turbocharger, downstream of the

carburetor, starts pumping additional air into the cylinders only when the accelerator goes down. It makes no difference whether the pedal has no pressure on it, or is halfway or three-fourths of the way to the toeboard—at any steady accelerator pressure, the exhaust volume is constant. But the moment the accelerator is depressed farther, exhaust volume mounts. The turbine “reads” this increase. The pump at the other end of the shaft begins pouring more air-fuel mixture from the carburetor into the cylinders.

At full throttle, 25 pounds. The added power comes from this pumping. Pressures in the cylinders shoot up. Without the turbocharger, there is only atmospheric pressure to force the charge into the cylinders. At sea level, that's 14.7 pounds to the square inch. With the Corvair turbocharger, pressure at full



TURBINE (upper wheel) and pump, on common shaft—each three inches in diameter—are so alike as to be almost interchangeable.



INSTRUMENT PANEL on supercharged Corvair should keep engine buffs happy. Tachometer on left registers up to 6,000 r.p.m.; speedometer climbs to 120 m.p.h. Upper two dials on right show manifold pressure and cylinder-head temperature. Fuel gauge is centered beneath them.

throttle goes up more than 10 extra pounds, to 25.

Hark, now, to what they have done to the Corvair engine, because it's at this point that all superchargers, whether mechanically or turbine driven, run head-on into a complication peculiar to internal-combustion engines. As more air is crammed into the cylinders, the pressure shoots up past the point where the highest octane fuel available can accommodate a high compression ratio. The engine begins knocking—not from the pressure but from the heat induced by it.

The turbocharger does have an advantage over the mechanical supercharger: It operates only a fraction of the time. That saves fuel. But it still runs into the knock problem.

Oldsmobile proposes to solve this in its forthcoming F-85 turbocharged engine, without cutting back on the compression ratio, by injecting water into the supercharged mixture to reduce the heat. This idea, announced last August, is still a-borning due to what Olds refers to vaguely as "technical difficulties."


Chevy has licked it more simply. First, they backed off one point on the compression ratio—from 9:1 (for the 102-hp. version) to 8. This is standard practice with superchargers. Next, they tailored the plumbing to restrict the supercharging to an extra seven-tenths of an atmosphere. For instance, while the turbine *could* whirl at 110,000 r.p.m. without damage, the gas volume actually allowed to bathe it permits a maximum of only 70,000.

Finally, Chevy balanced off the centrifugal spark advance with an intake-manifold sensor that retards the spark between 2,500 and 3,900 engine r.p.m. The centrifugal advance up to that point is 24 degrees before top dead center. The manifold retard cuts this to 15 degrees. Result: no ping. At 3,900 r.p.m. the advance is allowed to proceed up to 27 degrees. Here, the engine is past the point of "lugging"—of straining to meet the demands of the accelerator.

This might be called reverse English on the ordinary manifold-vacuum spark advance.

To make it work. Chevy had to do a number of other things, too. When

[\[Continued on page 243\]](#)



Millions of words a minute...

The Marvelous March of the Microwaves

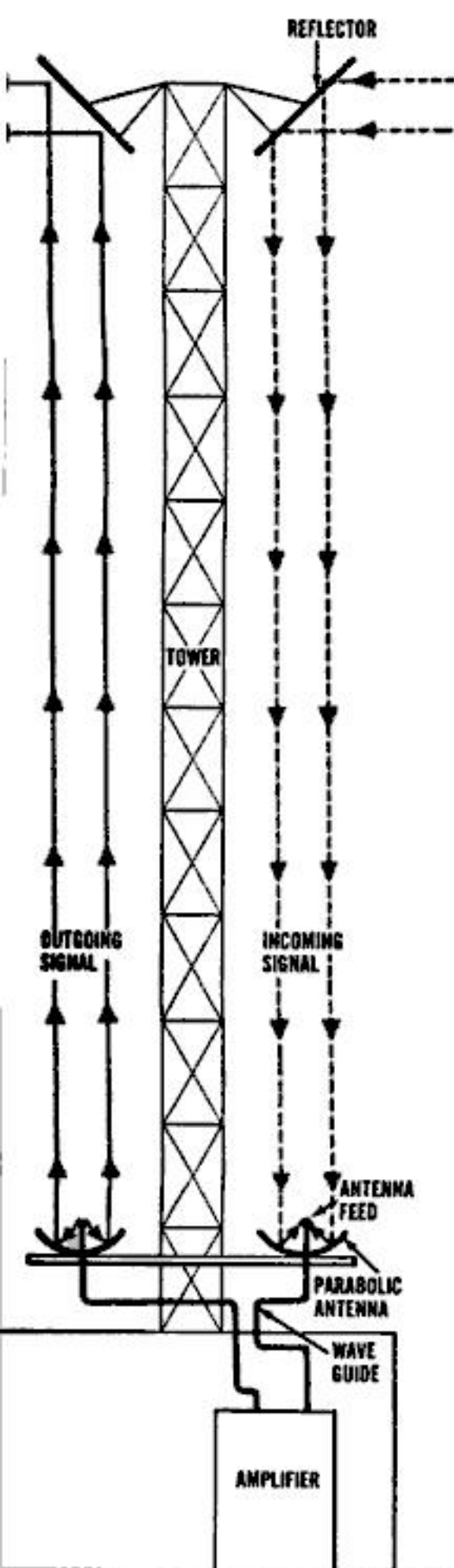
***Tiny inch-long beams now do most of the
TV or telephone talking from coast to coast***

By Harland Manchester

ON A Pennsylvania hilltop a few miles east of Doylestown stands an isolated concrete-block building beside a short steel tower. If you knocked on the door you would find nobody home. Bolted to the eastern side of the tower are a pair of antennas each approximately 10 feet square. Facing west is a similar pair of antennas. To drivers on Route U. S. 202 this structure looks like an idle bit of electronic gadgetry. Actually it is a vital link in one of the greatest traffic systems the world has ever seen. Its traffic, which surges in one antenna and out the other

CONTINUED

Want to dial the moon direct? Don't laugh. It's only



Reflector at top right picks up weak incoming beam, guides it down to amplifier to be built up and bounced out again through reflector on the left.

24 hours a day, 365 days a year, is composed of voices, music, pictures, business data and anything else in the field of sight and sound that the most communicative people on earth have a yen to say or show to one another.

Through this drab little shack pass the wheel creaks of *Wagon Train*, the slap of *Maverick's* aces, the curves of starlets, the gleam of detergents, and all the other dream-fodder packages processed by Hollywood and Madison Avenue. Through it stream the magic vibrations that are reassembled into great symphonies, the world's news in voice and picture, weather reports, the robot chatter of computers, and telephone calls to distant points at the rate of 33,000 a day.

If this shack handled nothing but telephone calls, it would route 240,000 words through its "dishes" every minute at the average rate of talk, and it would take about 400 pairs of wires on old-fashioned pole-and-wire lines to carry the same volume of conversation. With 8 wires to a crossarm it would take a pole 220 feet high to transmit the calls handled by its antennas.

This relay station is only one unit of the vast microwave radio systems that has been installed throughout the United States in the last 11 years. It is part of the American Telephone and Telegraph Company's huge network (world's largest) of about 2,000 stations which now span the continent, with branching tentacles reaching all the major cities and towns in the country. And there are many similar networks, operated by other communications firms and by private industries.

A map of the country showing all these stations would be speckled with about 6,000 dots, and at least 400 more are being added every year. Fill in the lines connecting these aerial stations and you have an amazing new complex grid of microwave "highways" blanketing the nation. These networks are rapidly shouldering the fast-increasing burden of long-distance communication throughout the world, and they may soon make the telephone pole a relic of the past.

Those tiny, tiny waves. The microwaves used in these systems are radio waves of very short length and high frequency. By way of comparison, a 660-kilocycle station in the standard AM broadcasting band has a wave length of about a quarter of a mile. Microwaves run from about a foot to a fraction of an inch long, which means that they travel at the rate of billions a second instead of the mere hundreds of thousands of the long broadcasting waves.

These tiny waves behave quite differently in many ways and have made many new radio techniques possible. Long waves are suitable only for broadcasting in all directions, and cannot be focused into a beam without building an antenna the size of a sports stadium. But since microwaves are near the visible light band in the spectrum, they behave somewhat like light. They can be bunched by a parabolic reflector and directed in a sharp, narrow beam like that of a searchlight. And, like light, they will not travel over the horizon (except under freak conditions)

a few steps beyond today's world-webbing microwave network

and are stopped dead by any solid object in their path.

This trait led to the development of radar in World War II. Beams of microwaves scanned the sky, and their reflections back to receivers by airplanes showed the position and distance of the enemy craft. Radar research spurred peacetime applications. The first relay networks to connect U. S. cities proved their value in 1945, and most of today's networks have been set up in the last decade.

"Beaming" the waves.

Since microwave transmission is limited to "line of sight," the relay stations are located 25 to 30 miles apart, sometimes closer if the terrain demands it. Many of them are on hilltops or buildings, some on towers as high as 350 feet.

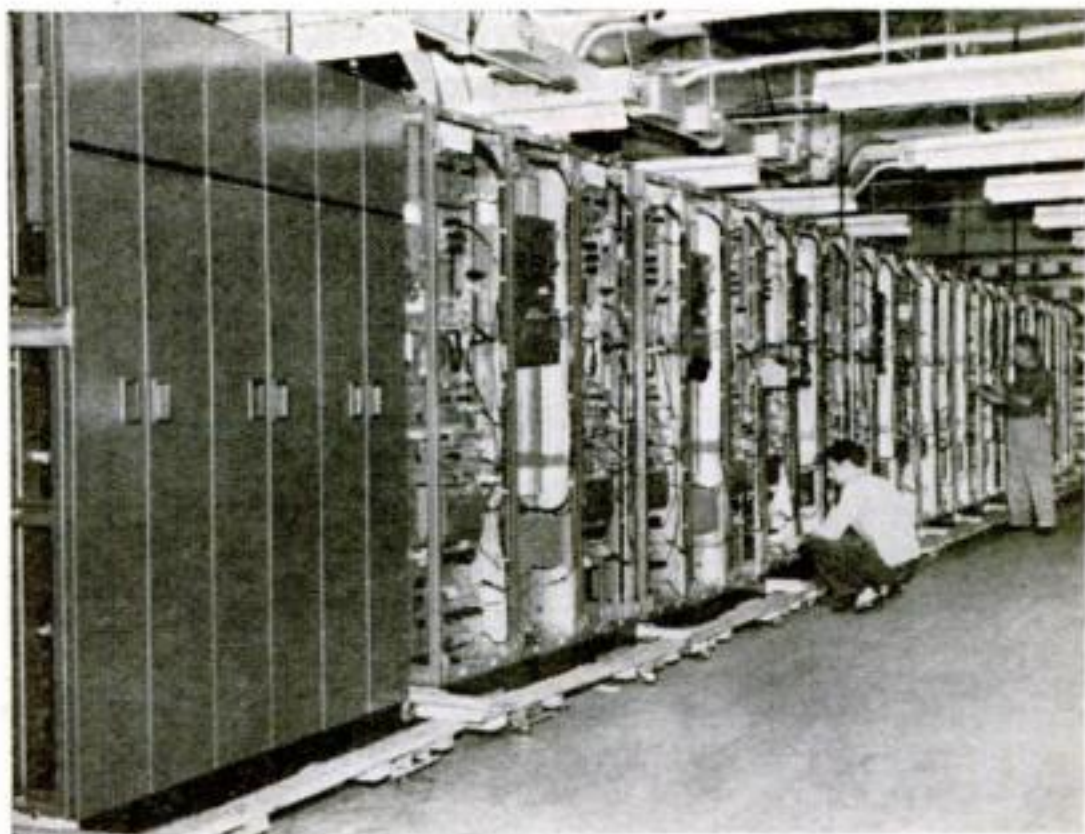
The package of radio signals, which in a trunk network may represent several TV programs and a few hundred phone calls, is beamed from one antenna, or "dish," to a corresponding dish at the next station. The beam fans out like a light beam, and much of it is lost, but enough of the waves are caught to transmit a clear signal. This is dispatched through wave guides, or pipes, to amplifying equipment in the station, built up to its original strength, piped back up the tower to the transmitter, and beamed along on the next leg of its journey.

Along the line there are substations, where packets of information tagged for local destinations are screened out from the main artery and routed along auxiliary microwave chains to distribution points in cities and towns along the way. There the messages and pictures are converted into the frequencies used by home TV receivers, radios, and telephones. Supplementing the microwave networks are thousands of miles of buried coaxial cables and ordinary telephone lines. A long-distance phone call may use all these channels in completing a circuit—it doesn't matter to the customer.

Another national network of microwave "super-high-



Longest microwave hop sends TV signal from Utah peak to Idaho station 136 miles away.

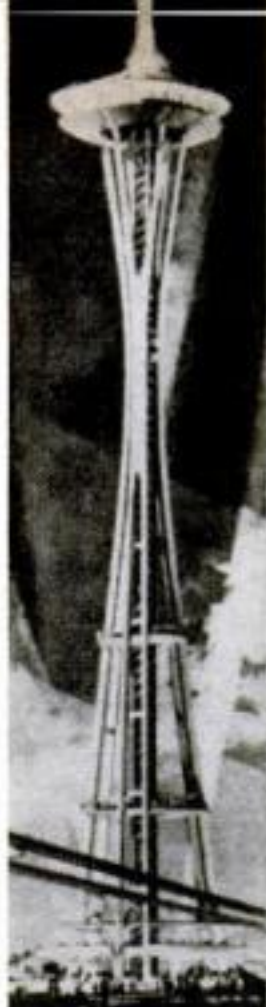


Robot transmitter-receiver racks power one network. The system can handle 2,400,000 words a minute.

[Continued on page 218]

What'll It Be Like in 2000 A.D.?

**Seattle World's
Fair provides
fascinating
previews of
marvels in store
for Americans
of the
21st Century**



By Wesley S. Griswold

BENEATH the dramatic, 60-story Space Needle (left) that dominates the Seattle World's Fair, opening this month, a world of future wonders is revealed.

Take a look, for instance, at the dazzling view of America in 2000 A.D. that Standard Oil of California provides in its big diorama. The drawings on these pages sketch a few of its details.

Huge, rocket airliners that can take off and land vertically soar through the skies. Individuals take to the air in scooters. Big jet helicopters serve as aerial buses and trucks. A few gyrocopters—silent as a breeze—float overhead.

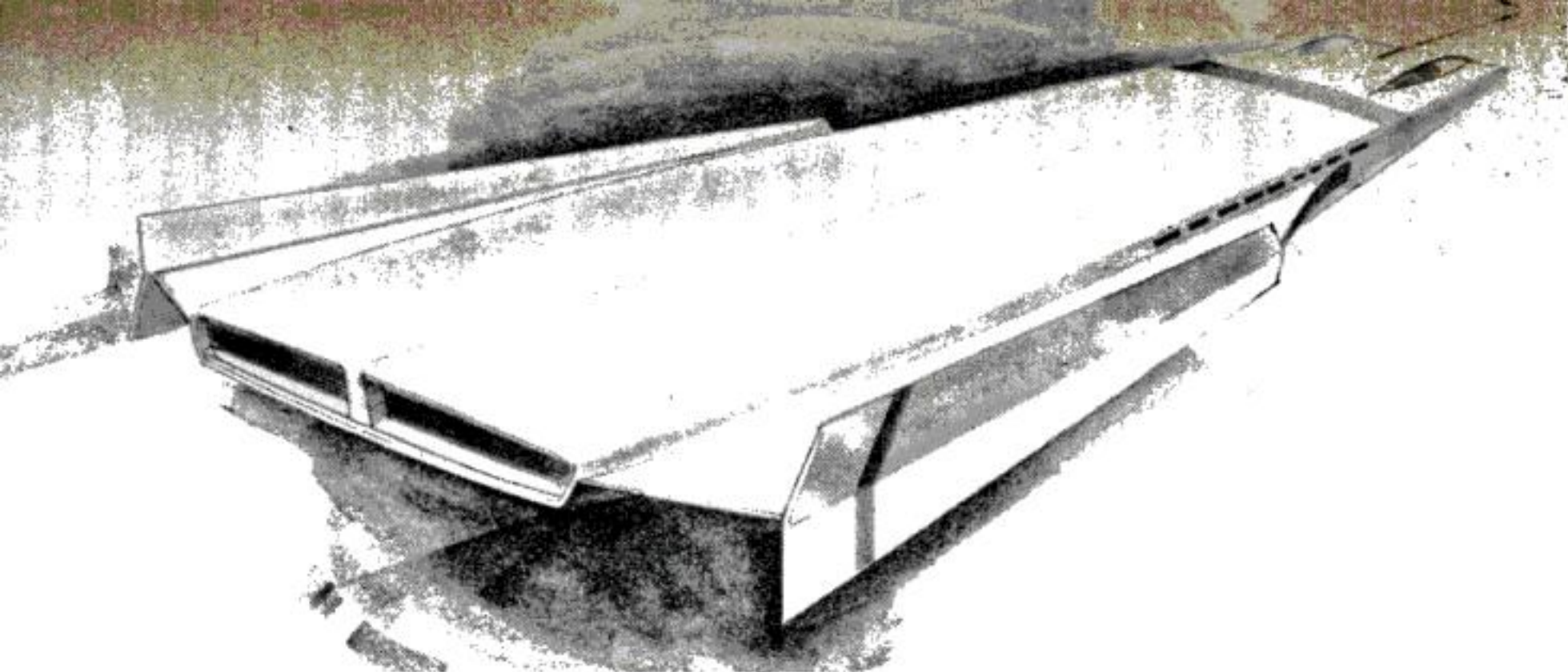
Not far above the ground, jet-propelled monorail trains rush the daily commuter traffic to its destinations. Underground, rocket subways roar through plastic tubes. Over electronically controlled superhighways, family ground-effect cars whisk along on cushions of air. When a driver reaches his exit, he lets down the car's retractable wheels and drives off onto a noncontrolled access road.

The superhighways are surfaced with colored plastic, various hues indicating the fast, slow, and exit lanes.

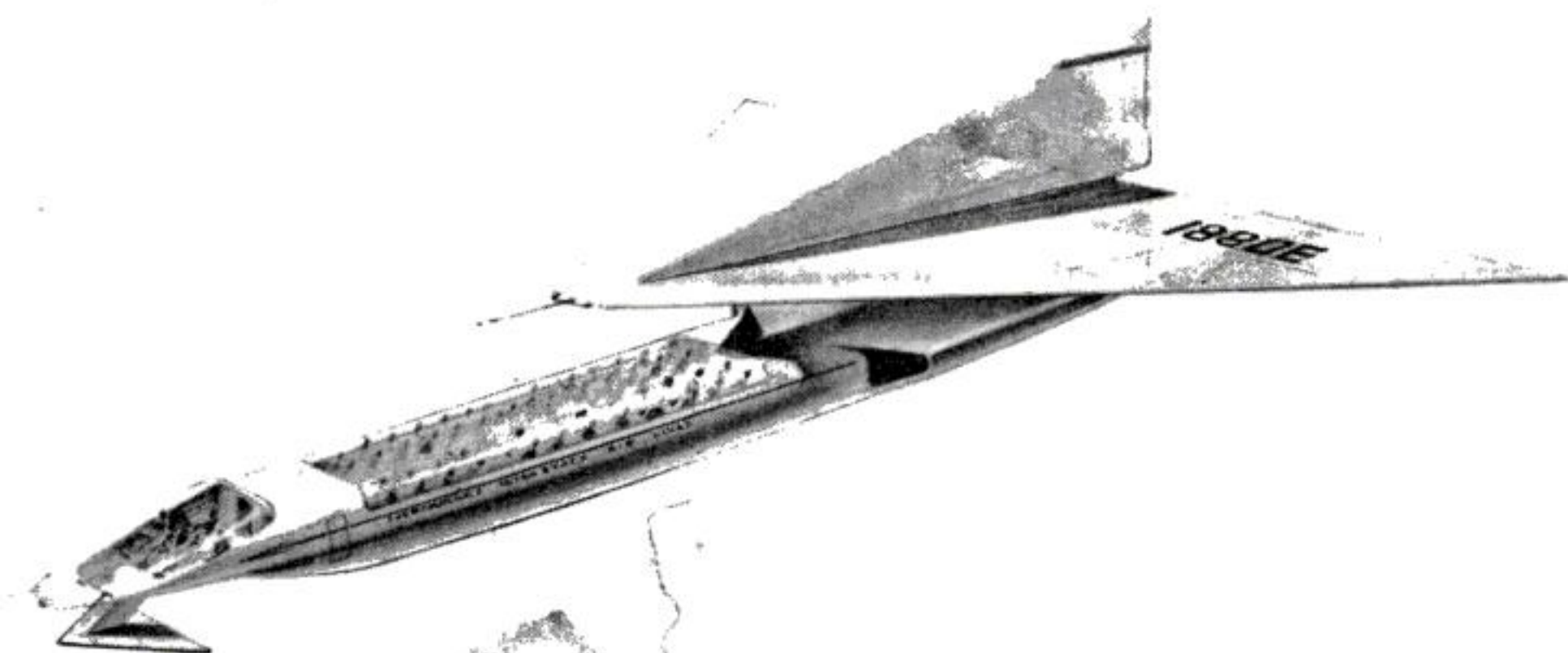
Even more remarkable is the way these highways are built. Monster earth movers, chewing solid obstacles to bits, pulverize trees and rocks to prepare the roadbed. Behind them come machines that lay eight lanes of plastic pavement at the rate of five miles an hour. Sixty minutes later, the road is firm enough for traffic.

A CLOSER look at a possible automatic highway of the 21st Century is offered by General Motors. Among the GM displays at the Seattle Fair is a working scale model of a turnpike on which the inside lane in each direction is under complete electronic control. Cars are steered, accelerated, braked, or stopped without any assistance from their drivers.

Imagine this to be a real highway of Century 21. Its controls are various current-carrying wires buried in the pavement. Pickup coils are mounted on the cars. The signals they induct are flashed to electrohydraulic servos, which work the steering gear, the accelerator,



Crossing the Atlantic Ocean in an hour is forecast with supersonic airliners like this model.



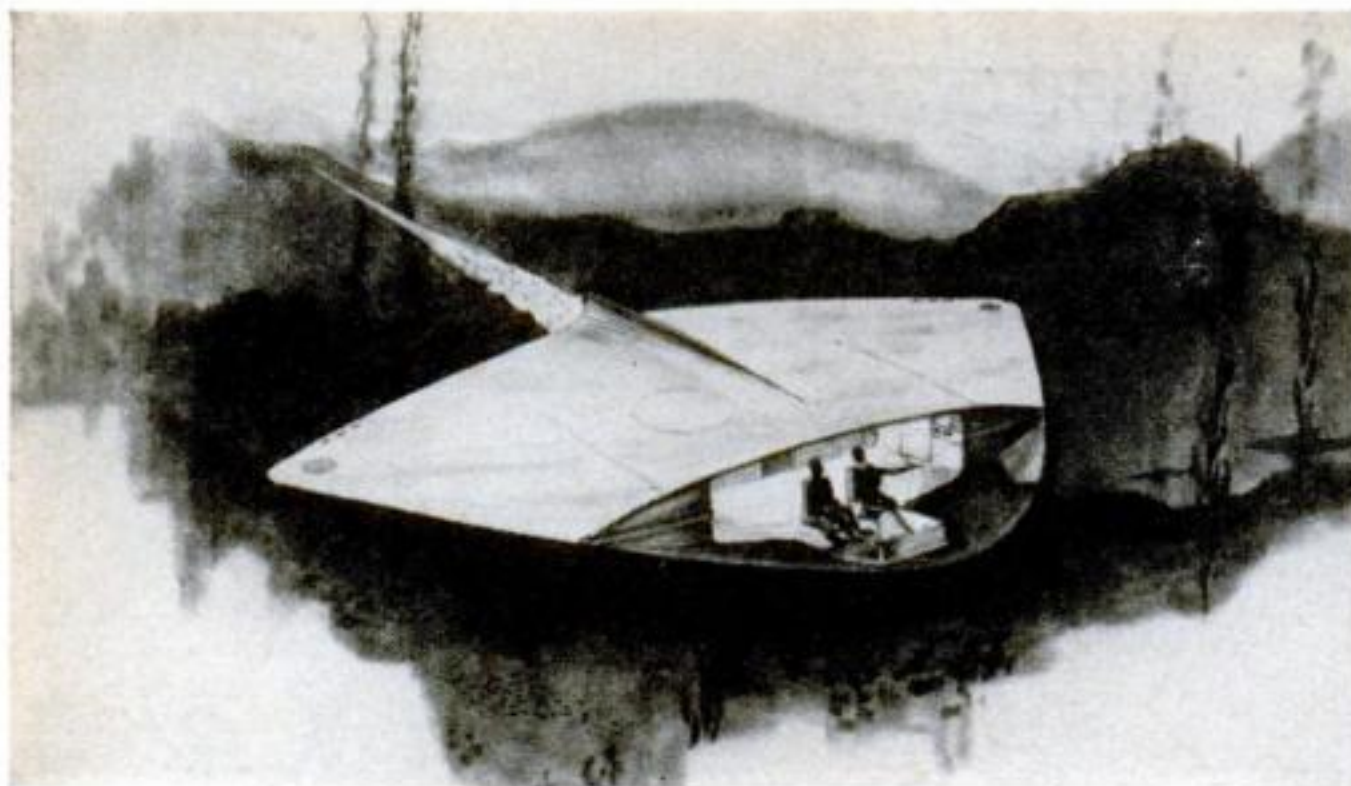
On shorter continental hops, air travelers of the year 2000 may watch the sights through domes.



A working model of this family air car, with vertical takeoff and landing ability, is at the Fair.

CONTINUED

For the 21st Century: a family sub for undersea



FAMILY SUBMARINE shaped like a manta ray, with a broad bow window through which to view marine wonders in comfort, is among the diverting models in Standard Oil of California's diorama of U. S. life in the next century. This Fair exhibit predicts that the sub will be driven by electricity generated by a petroleum fuel cell.

and the brakes. Meanwhile, the driver can safely take a snooze if he likes.

Even if his car runs out of gas, there's no chance of a crash. A stalled vehicle causes the highway-control system to halt every following car before it can get into trouble.

Drivers can then switch off their connection with the highway controls long enough to steer around the obstacle and get back on "automatic."

WHAT the driver comes home to at the end of his journey promises to be the most extraordinary of all aspects of life in the year 2000.

As Standard Oil foresees it at the Fair, each 21st Century householder generates his own electricity as well as heat with the aid of a petroleum-powered fuel cell. In fact, the home's lighting, refrigeration, air conditioning, heating, and waste disposal are all handled by a utility unit the size of a standard office desk.

All necessary distributing ducts are built into the plastic walls, which glow with polarized light of selected colors.

For people who love to watch plants grow, some of these homes have environmentally controlled window gardens. Here, with the aid of growth chemicals and artificial heat and light, several crops of vegetables and flowers a year can be raised.

A more detailed picture of the marvels inside the 21st Century home is revealed in the Fair's theme diorama, "The World

of Tomorrow." This display, centered in the futuristic Coliseum, is drenched with novel sound and lighting effects.

Here are houses put together with chemical fasteners in place of nails, built of color-impregnated materials that never need painting, and kept clean by high-frequency sound. The homes have solar ovens for use on clear days, microwave ovens for stormy days. Each chair or sofa can be heated or cooled individually to suit the sitter. Heating devices are woven into the rugs and installed in the walls. Some exterior walls are simply curtains of warm or cool air, leaving the adjacent rooms open to all outdoors yet shielded from winter and summer temperature extremes.

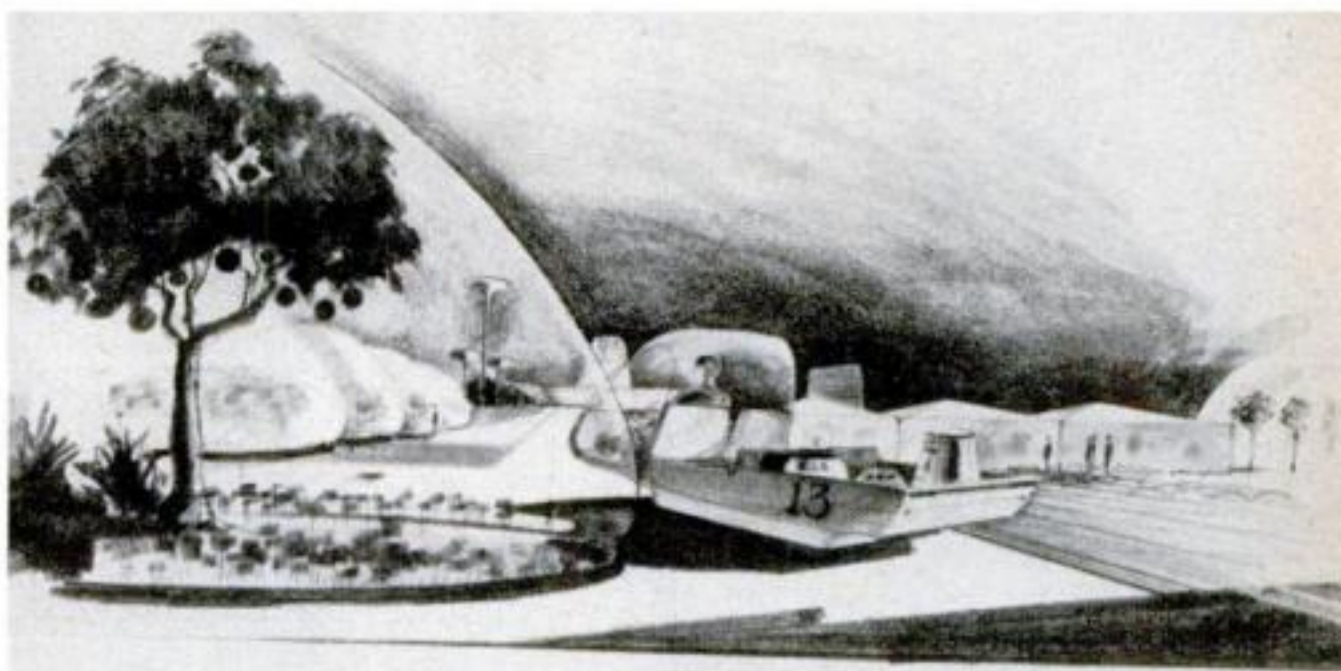
If you lived in one of these houses, according to the exhibit, you'd wear lightweight, all-year, disposable clothing and incredibly durable plastic shoes. You'd sleep between disposable sheets, on hydraulically adjustable beds. You'd eat from disposable dishes.

Your family's store of frozen food would be kept in big cellar freezers, which would rise to the kitchen at the touch of a button. The household garbage, if not ground up and washed away, could be frozen to wait for the pickup truck, or compressed into pellets and dried for use as fertilizer.

DOMESTIC computers, sometimes casually given their instructions over the telephone, would be your servants.

exploring . . . and a plastic dome with made-to-order climate

ANY KIND OF WEATHER can be produced under the plastic domes of this farm of the future, also part of Standard Oil's diorama at the Seattle World's Fair. The farmer, shown here in a ground-effect vehicle, is expected to superintend a largely automatic food factory that raises crops, packages and delivers them.



They'd order electronic mowers to cut the grass around the house and tell them what pattern of mowing to follow. They'd turn on the oven, govern the cooking, arrange for heating the baby's milk, record phone messages, transfer calls.

As AT&T foresees communications of the next century in its Fair exhibit, the people who live in these U. S. homes will be making at least a billion phone calls a day. Much of this enormous conversational traffic will ride on beams of light. Many of the phones will be cordless. Many will be videophones. These will be private, closed-circuit TV transmitter-receivers, enabling the caller to see the person he's talking with. Between offices hundreds of miles apart, machine will "talk" to machine, as computers automatically feed data to each other.

By this time, AT&T explains, a girdle of Telstars, or communications satellites, will be circling the earth. Conversations, recorded information, and TV programs will be beamed at these satellites, which can relay them anywhere in the world.

Home entertainment, according to RCA's preview of the future, will come in a striking array of packages. All television will be in color. It will be viewed on sets that range from book size to a very large set, only five inches thick, with a remotely controlled sliding cover for its screen. One such console will offer a choice of live or preselected taped TV shows, plus stereophonic radio and tape recorder.

RCA also predicts in its Fair exhibit that the home communications system of 2000 will let a housewife use her TV set to watch the children or see who's at the door as well as to view a distant show.

IN THE coming century, specialty farmers with 25 to 50 acres will be able to select their own climate. At least, so the Standard Oil of California diorama at the Fair anticipates. This display shows entire farms enclosed in enormous plastic bubbles. Under these transparent domes, held up by surprisingly little air pressure, climate is blended and regulated by computers. Here, farmers grow fruits and vegetables in arbitrary shapes that package well—for instance, square tomatoes. Water, fluid fertilizers, and insecticides are all pumped to the crops through perforated plastic pipes.

An inexhaustible supply of water for this farm and for, in fact, all the U. S. of Century 21 comes from sea-water conversion plants.

The Standard Oil people envision a lot going on at sea at this future date. Hydrofoil liners will race across the surface. Under it, inflatable submarine tankers and freighters will slide along unseen. Ocean-bottom oil exploration and drilling will be carried on by big, saucer-shaped submersibles. Large-scale underwater farming of nutritive aquatic plants will help feed the bulging world.

Industries aren't the only ones at the

[Continued on page 214]



**What You Should
Know About**

Fallout Meters

Detectors can't shield you against perilous radiation, but they warn you of the invisible dangers. Here are facts about the different types: what they do and how they do it

By Martin Mann

ONE horror of atomic war would be your very own personal problem: radiation. You can't see it, feel it, hear it, taste it, or smell it. But it could kill you.

Ingenious electronic gadgets make up for this human insensitivity. They sniff radiation better than a hound scents quail. And they may be essential to survival in this perilous age. Without them, you could walk into mortal danger completely unaware.

If you're planning a family fallout shelter, a meter is *must* equipment. There are many on the market, at many prices. Only three types are "acceptable" to the U. S. Office of Civil Defense (the ones not accepted may be good, but different, as you'll see later).

The Problem

The radiation you have to worry about most is gamma rays: power-packed bundles of energy, similar to X rays, that disrupt body processes to cause sickness or death. They are measured in roentgens (abbreviated "r"). The gamma rays come from radioactive fallout, the deadly dust that would settle—unevenly—over wide areas after some, but not all, types of atomic attack.

To duck this menace you really need two different types of radiation meters. One is a ratemeter, reading roentgens per hour (r/hr.). It measures how fast you are soaking up radiation, just as a speedometer on a car measures how fast you are piling up mileage. The other is a dosimeter, reading straight roentgens. It keeps a running tally of your total exposure to radiation—the way the mileage counter on a car tells how far you have traveled.

A high reading on the ratemeter warns of immediate danger but not necessarily irreparable harm—like seeing the needle touch 95 in a car. A high reading on the

dosimeter means you've had it—like seeing 95,000 on the odometer of a jalopy.

You don't have to invest in both types, however. A ratemeter will also serve as a dosimeter, and some dosimeters can serve as ratemeters. The only extra you need is a watch. If the ratemeter reads 10 r/hr. steadily for an hour, you have added 10r to your accumulated dose. And vice versa: If a dosimeter reading increases 10r in an hour, the rate is 10 r/hr.

The Solutions

The best-known of the home owners' meters, the Bendix, is a dosimeter—or really two separate dosimeters plus a charger. One dosimeter measures low levels of radiation and is used as a ratemeter—you stick it out the door for either one minute or ten minutes and read r/hr. directly off the appropriate scale (there are two). The other unit can measure large amounts of radiation and is used as a straight dosimeter—you keep it in your pocket and check every now and then to see how many roentgens you have piled on.

The other two meters, made by Lionel and Victoreen, are just now emerging from the red tape of Civil Defense acceptance tests. They measure rate and read r/hr., indicating immediately how dangerous a particular place is. You would still need to know how big a dose you were accumulating, so you would have to keep a written log: so many hours at this number of r/hr., so many hours at that number, and so on until the radiation level dropped too low to show on the meter.

How to Use Them

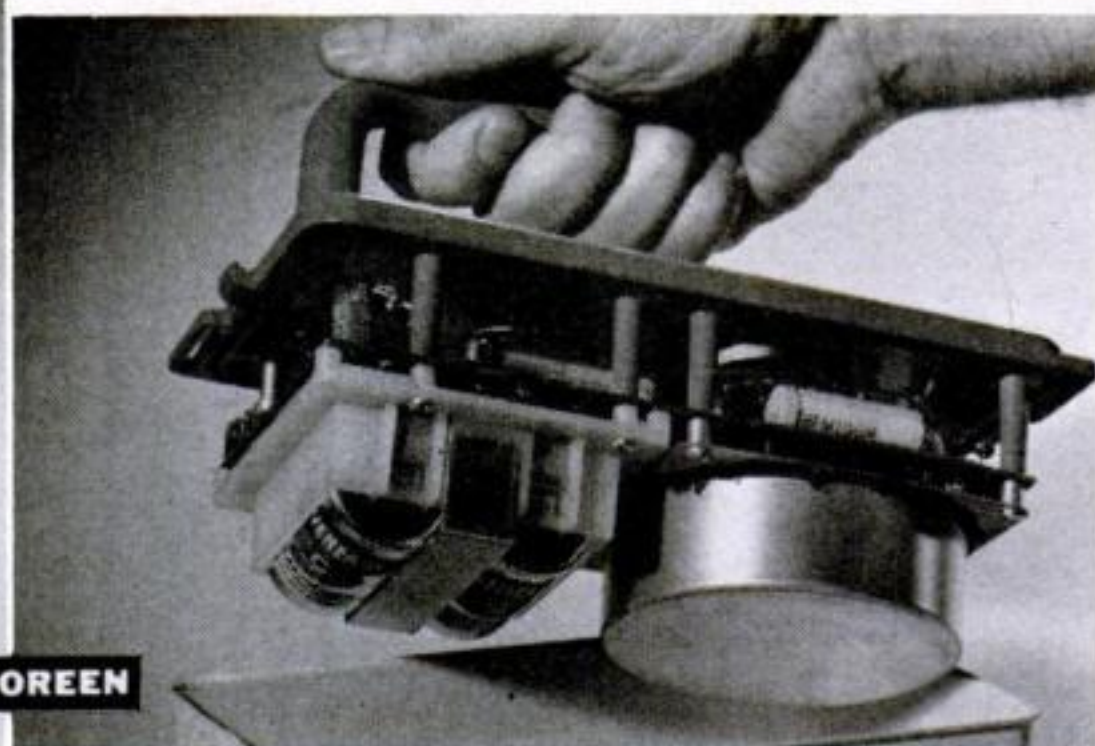
Anybody with enough technical savvy to operate a photographic exposure meter can run a radiation detector. First you put in the batteries (standard flashlight cells). You check the electronic circuits

[Text continued on page 204]

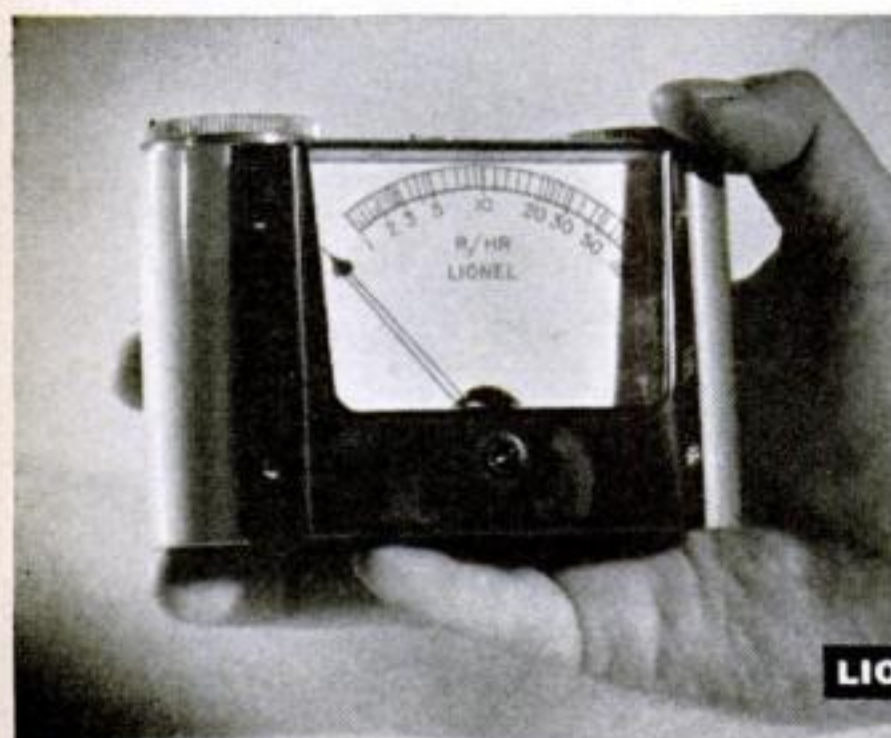
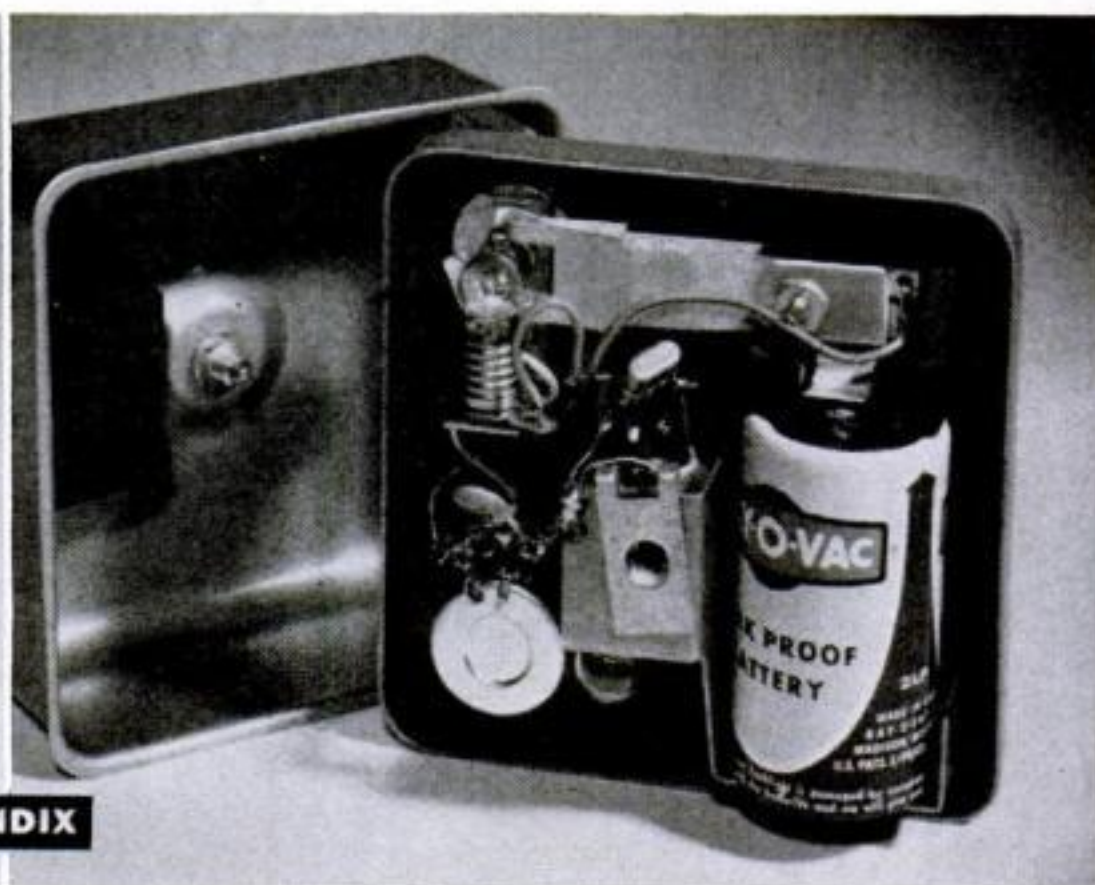
Three fallout meters have



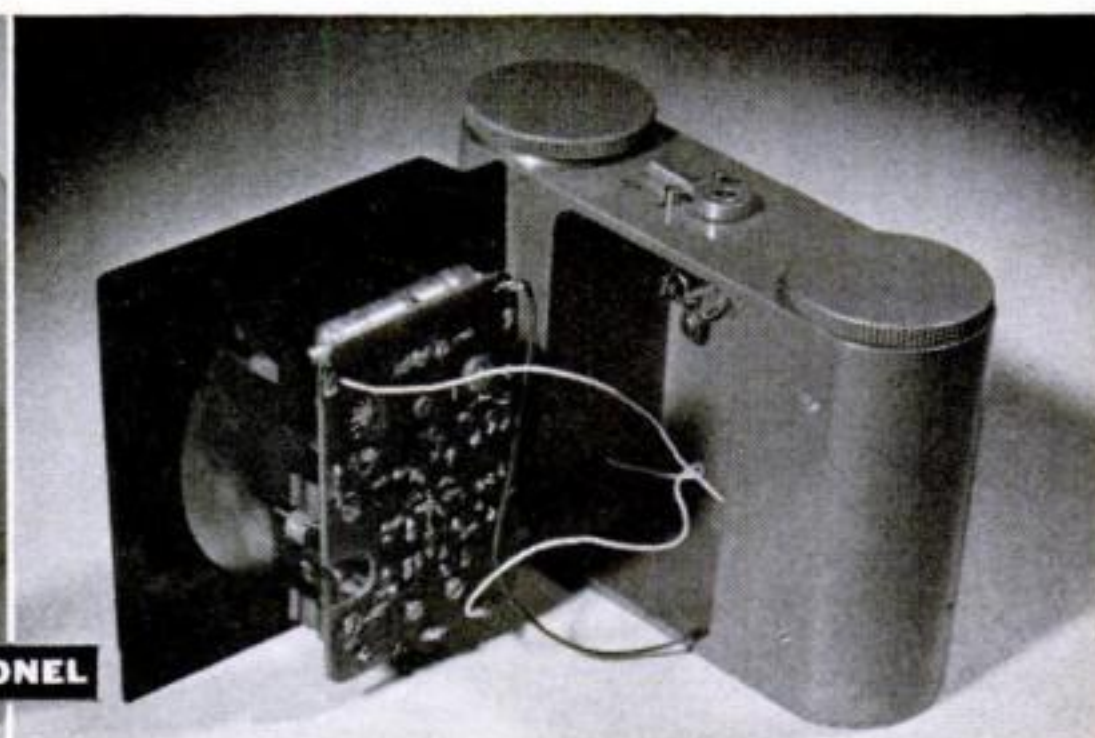
VICTOREEN



BENDIX



LIONEL



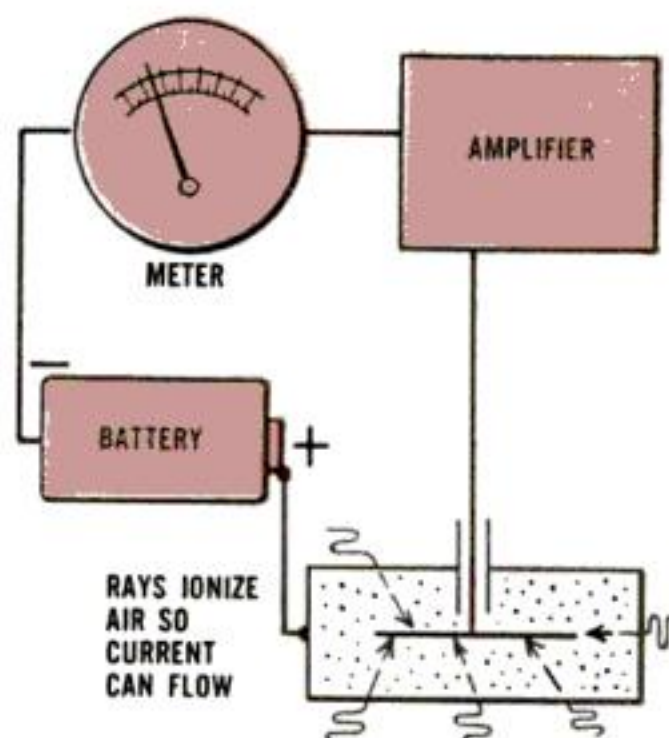
been designed for civilian use—and each works differently

The “works” of the Victoreen meter is what physicists call an ionization chamber. It looks like an oversize tuna-fish can. (There are also a special vacuum tube, some transistors, printed circuits, and similar hardware.)

The can is sealed. It contains a mixture of dry gases (a secret formula, but mostly air). One electrode pokes down into the center of the can; the other electrode is the can itself.

Since dry gases do not conduct electricity, no current ordinarily flows between the electrodes. The meter (a simple microammeter) reads zero.

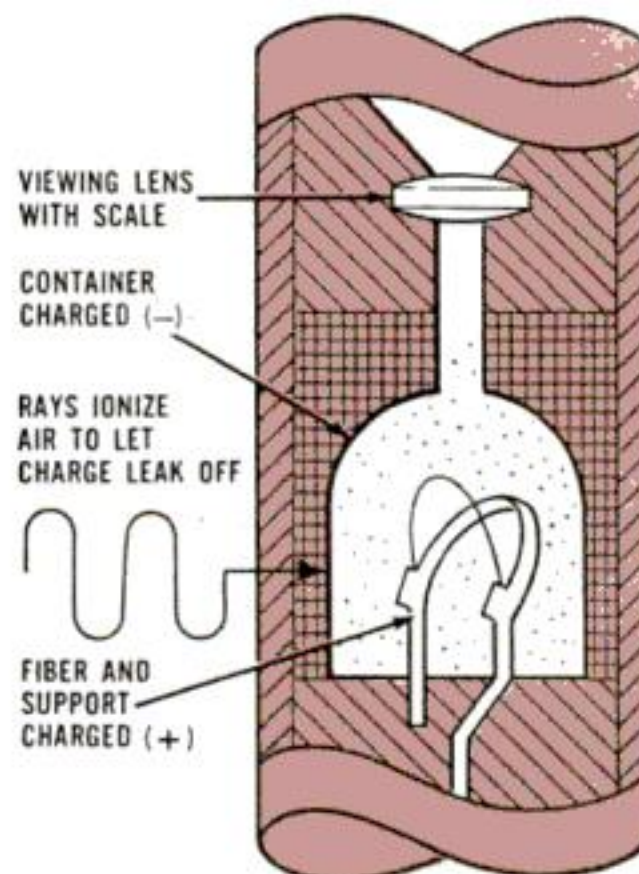
That's when there are no gamma rays about. Gamma rays ionize the gas atoms inside the can (same thing that happens in Bendix's electroscope, below). The electrically charged ions can conduct electricity. So current flows between the electrodes. And the meter needle moves up from zero. The more gamma rays around, the greater the current that flows, and the higher the meter reading.



The Bendix meter is just an electroscope like the ones with which high-school science teachers demonstrate static electricity. Sealed inside the fountain-pen-like case is a very fine, gold-plated quartz fiber. When you charge the fiber with electricity (by plugging the case into the charger box), electrical repulsion between the fiber and its support pushes the fiber over. The fiber will stand away until the charge leaks off or is neutralized. Ordinarily this takes a very long time, since the fiber and its support are sealed in a container filled with dry air, a nonconductor of electricity.

Gamma rays from fallout change that. Zipping through the container, they knock electrically charged fragments (electrons) off some atoms in the air and onto other atoms. These atoms become electrically charged ions. Some of the ions are attracted to the fiber and neutralize its charge. With less electrical charge on the fiber, the repulsion is less, and the fiber moves closer to the support. As more and more gamma rays come in, the fiber moves closer and closer.

To read this meter, you point the fountain pen at a light and look into its lens. The fiber itself serves as a pointer moving across a scale.

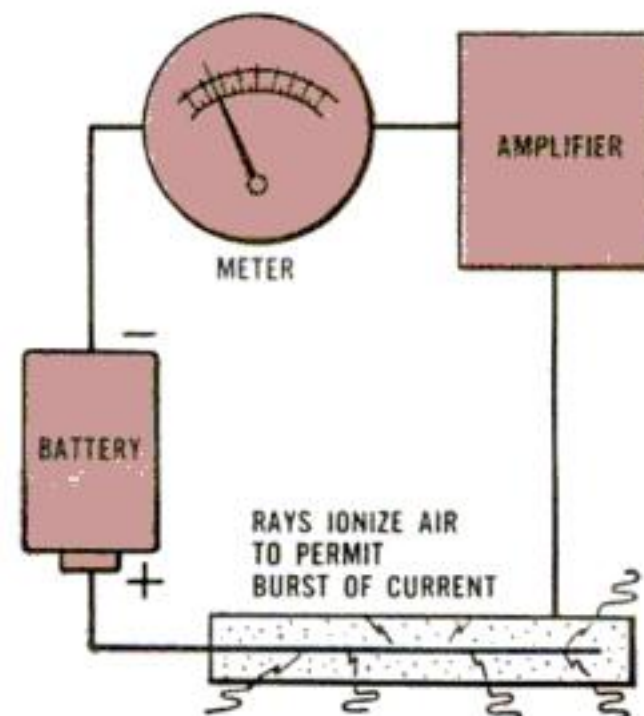


The Lionel meter is a Geiger counter, but different from the ones used for science shows and uranium prospecting. It is designed for much higher radiation levels and indicates measurements on an ammeter instead of making audible clicks.

The Geiger tube is a small cylinder with one electrode down its center and another at the tube wall. It is filled with dry gases (another secret formula). The voltage across the electrodes is fairly high, almost but not quite high enough to make current burst across the gap between electrodes despite the insulating gas.

Gamma rays ionize the gas, reducing its insulating value. Then current will flash over and register on the meter.

The Lionel detector includes a built-in reference standard: a weakly radioactive pill inside a shielding cylinder. Turning a knob rotates the cylinder so that a window faces the Geiger tube. The meter can then be checked against this known radiation.

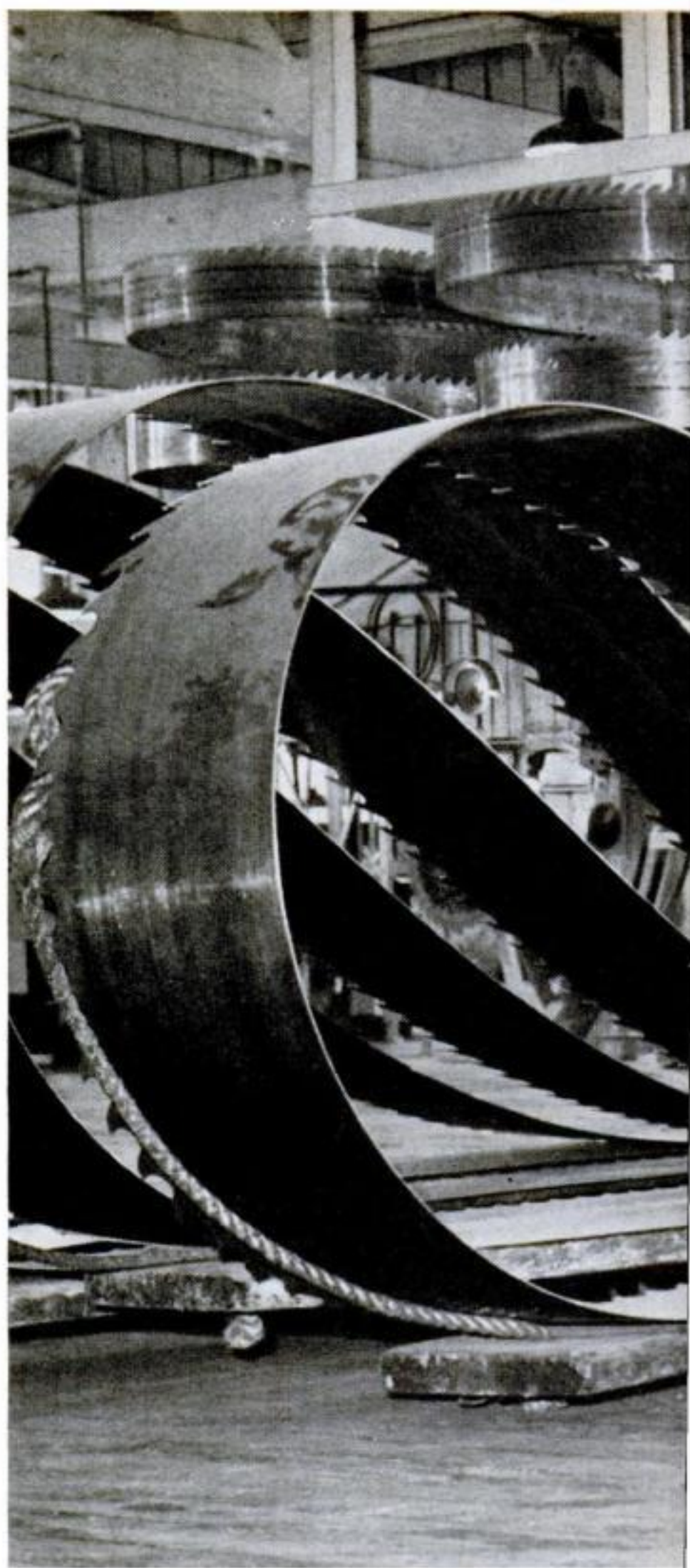


The Other Fellow's Job

Bug fighter. One of Eugene Mace's qualifications for his job is mosquito appeal. Mosquitoes like to bite him. That comes in handy for research on repellents, which must eventually be tested the hard way—by walking through a swamp, one arm sprayed, the other not, and then counting bites.

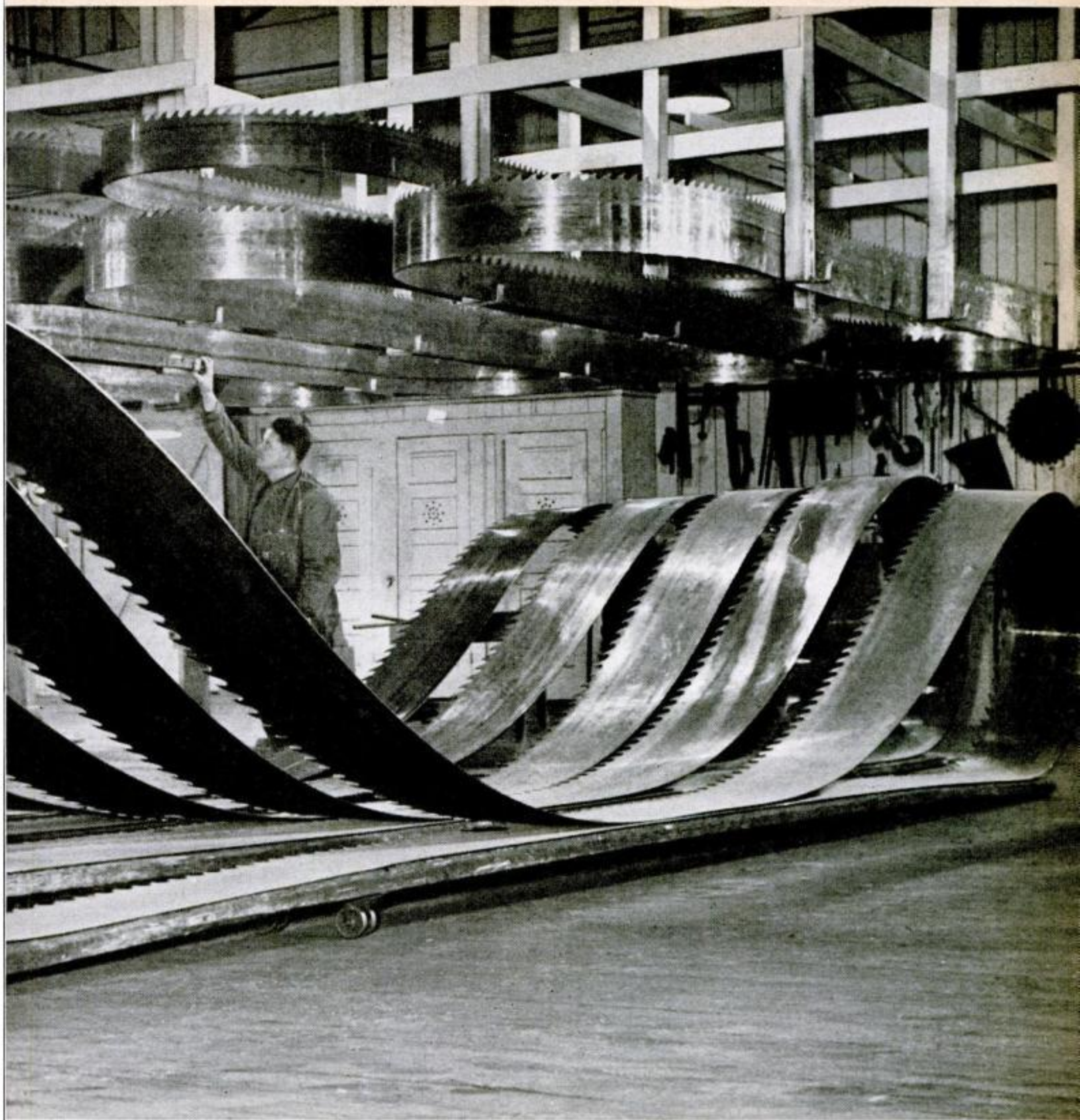
Mace, a Wisconsin-born, University of Wisconsin-trained entomologist, runs the bug laboratory for Johnson's Wax (big in the insecticide-repellent business). He breeds insects—there are usually 250,000 flies plus assorted mosquitoes, cockroaches, beetles, and borers in stock—and tries out the company's killers and shooers on them. (If a fly escapes, he has to swat it; spray would kill the caged insects.)

For this commercially important work, Mace is paid more than the average entomologist (\$8,000 to \$11,000 a year). He lives in Racine in a large house overlooking Lake Michigan. The two older of his three sons (10, 7, and 2), when asked Daddy's job, reply properly with all five syllables of entomologist.



Saw doctor. One shift of 10 men at Simpson Timber's new mill can rip 1,000 logs into enough lumber for eight or nine houses. Their saws—huge circular rigs, gigantic bands, oscillating gang saws—need sharpening every three or four hours.

The man who "puts up" these Gargantuan blades is Head Saw Filer Emil Johnson. The title is an anachronism. Rarely does he or his crew file anything. Automatic



machines set and grind the teeth. The sensitive handwork involves tensioning—stretching the middle of band or disk to make the blade bow. Then, rapidly spinning in use, the cutting edge will run straight and true.

The tricky jobs come after “wrecks.” Blades crack or spit teeth with a shield-scarring crash when they gnash against pebbles embedded in the logs. Wrecked blades are too valuable (\$650 to \$1,500

each) to discard. Practiced hands weld the breaks and attach new teeth.

Johnson, a 40-year veteran, supervises crews at three Simpson mills in Shelton, Wash. Expert saw filers are scarce and growing scarcer as automation intensifies demands for their skills. Pay reflects the scarcity: \$600 a month to start, with head saw filers drawing twice that. But the only training is on the job. Some of the men are still learning after 12 years.

CONTINUED



Long-boom man

There are 400 crane operators in New York City's skyrocketing construction industry, but barely two dozen of them can handle the long-boom machines. One of the best is quiet-voiced, youthful-looking Frank Gray.

The crane he works is a masterpiece of modern engineering. It's the boom that gets you—a lacy column of skinny tubing stretching 20 stories and more into the sky. Operating it calls for the deft touch of an artist. Gray must sense the tension in his cables and the swing and tilt of his boom from the feel of the control levers. Mistakes may be fatal. Too hard a swing at the wrong angle snaps the boom like a twig to drop four tons of concrete mix—and there are always men underneath.

Gray spots the dangling hook accurately (from hand signals; he can seldom see it) and fast. He transfers all the concrete from an 18-cubic-yard ready-mix truck in 25 minutes, keeping two 12-men crews busy. For the current job—the 12-story Talbot Hall apartments—he will maneuver that soaring boom through more than 2,500 lifts just for concrete pouring.

Such skill, acquired during a three- to five-year apprenticeship, commands real money: \$248 a week plus plenty of overtime. But only star performers like Gray work every week. The average crane operator, frequently idled by weather and business lulls, earns around \$7,000 a year.

Lawman on the road

Somehow state troopers turn out to be tall, broad-shouldered all-Americans. Richard M. Kleckner of the Delaware State Police—27 years old, six feet two, 190 pounds—is no exception. They didn't pick him for looks, however.

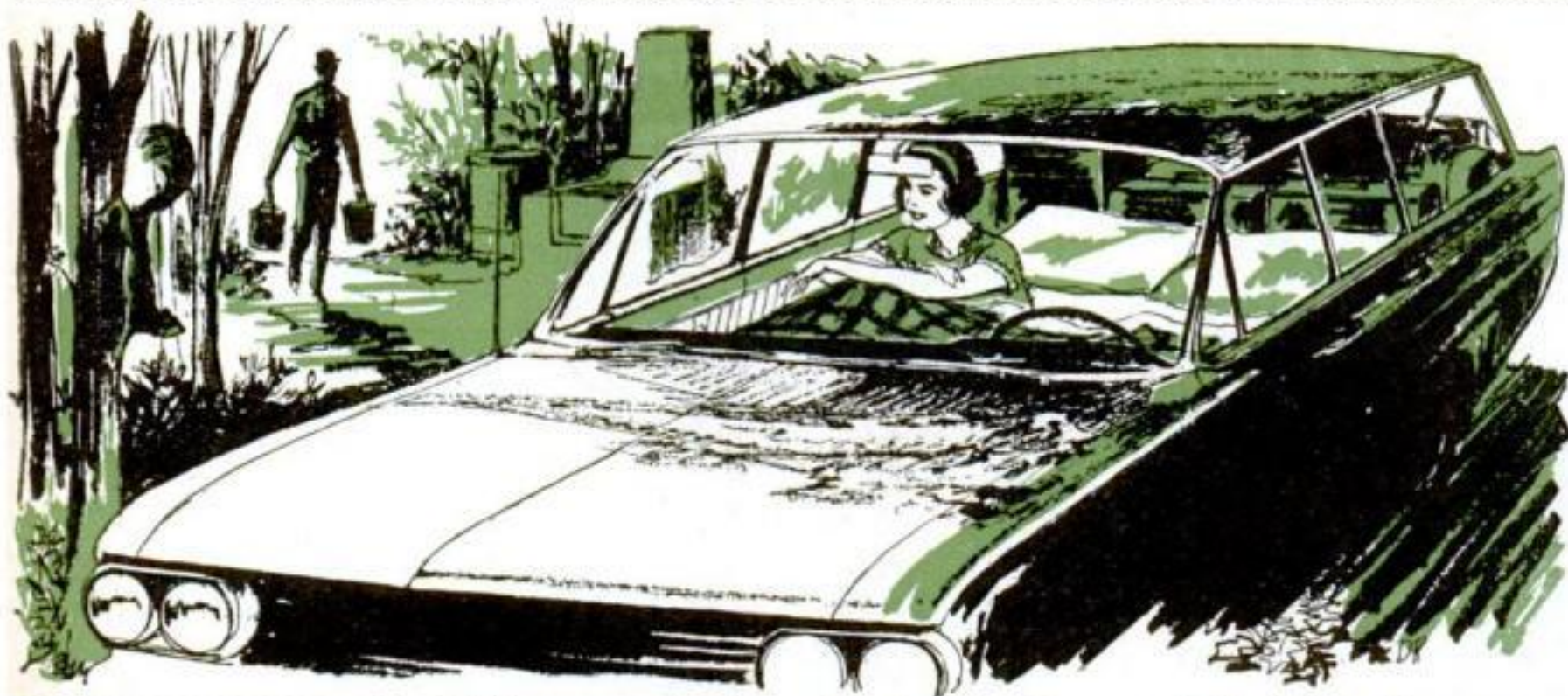
Trooper Kleckner is a sharp-eyed speeder-catcher, skillfully wheeling Car No. 313 (an unmarked Plymouth police special) on patrol near Dover. His captain considers him "outstanding," and even the erring motorists he flags down agree—several have written to praise his firm but courteous enforcement of traffic laws. Occasionally he gets into hairier operations. Last summer it was an expertly planned chase of a gang of car looters. He caught them, with an assist from Maryland cops, over the line near Berlin.

Kleckner more than meets the troopers' stiff standards, mentally as well as physically. From William Penn High School in Newcastle he went to prep school, then Annapolis and West Virginia State. He learned the technical skills of modern law enforcement in the eight-month state-police course, and then spent two years' apprenticeship as a probationary trooper.

Police pay has never been lavish. Kleckner makes \$4,400 a year now, but can expect steady advancement (corporal at \$5,600 after seven years). And long-range benefits are comforting—he could retire on half pay when he is only 44 years old.

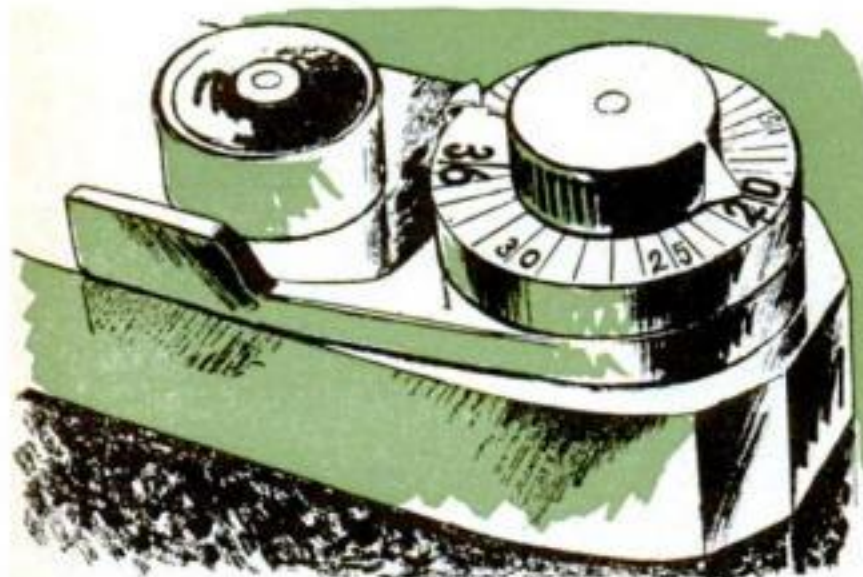


"I'd like to see them make..."

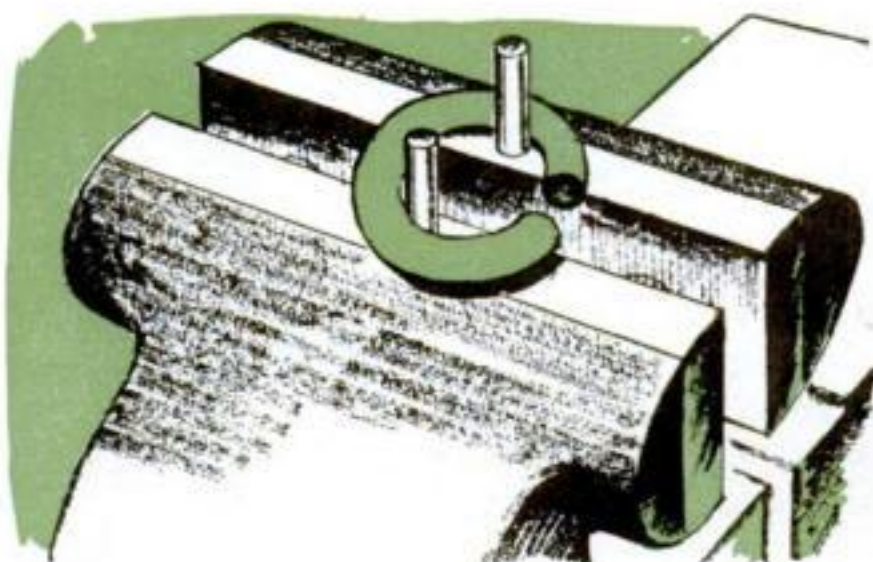


CAMPING WAGONS with fold-down seat backs, front and back. It'd eliminate unloading the car

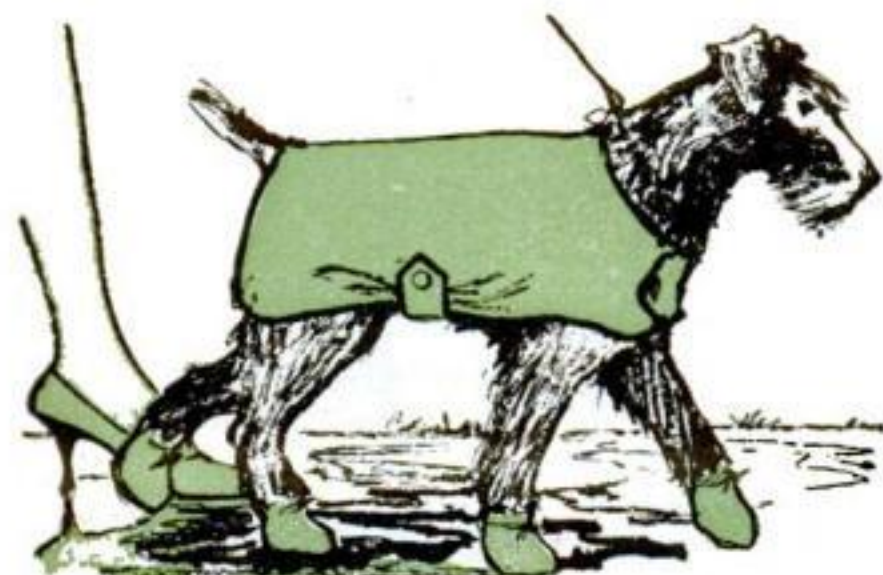
for sleeping. Gear could be left in the rear and under the bed.—*Mrs. B. Clark, Sidney, Nebr.*



A FILM LOCK on a 35-mm. camera that you could set for either 20- or 36-exposure rolls. It would prevent your unloading a 36 prematurely, or tearing a 20 loose.—*A. E. Ortner, NYC.*



A VISE WITH HOLES in the tops of the jaws so pins could be inserted. To open rings or spread U-shaped pieces of metal, you'd crank open the vise.—*Robert Tomb, Indiana, Pa.*



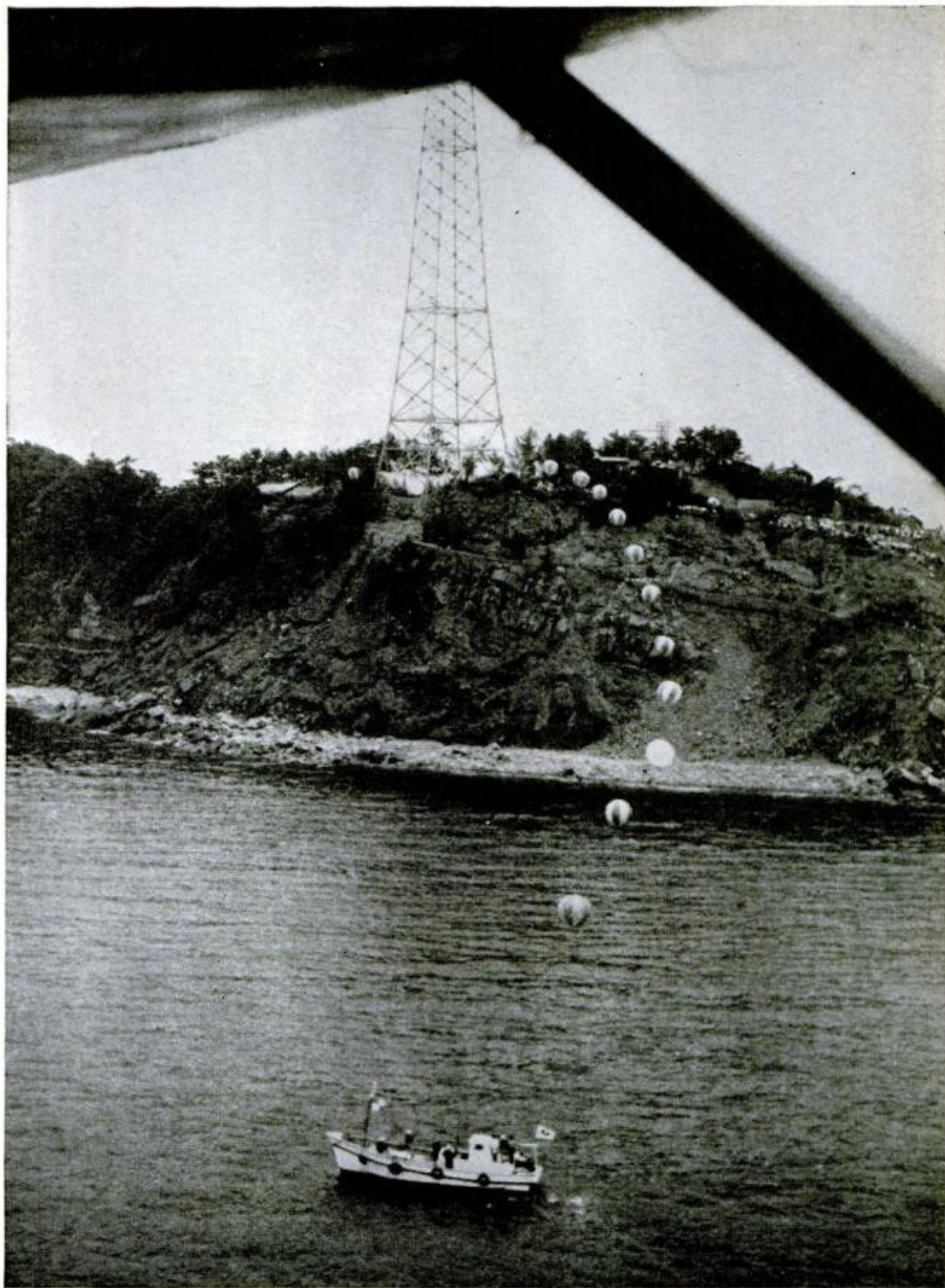
WATERPROOF PAPER BOOTS to keep a dog from tracking up the house on rainy or muddy days. After his walk, you'd slip them off and throw them away.—*Daniel Lavie, Jerusalem, Israel.*



EASY-TO-CLEAN STOVES with no top burners. Why not embed electric wiring in one of the space-vehicle ceramics that can withstand high heat?—*B. G. Holmes, Garden City, N.Y.*

Everyone has his own pet idea of a gadget that he would like to see in general use. What's *yours*? We will pay \$5 for each one published. Please use Government postcards

only. Send to ILTS Editor, Popular Science, 355 Lexington Ave., NYC 17. Write your name and address clearly. Contributions cannot be acknowledged or returned.



Airborne power cable

When Japanese linemen wanted to string a 5,500-foot power line across swift-flowing Naruto Strait, they took to the air. They tied 77 10-foot carnival-

colored balloons to the line at 60-foot intervals, attached one end to a tower at Fukura on Awaji Island and the other to a ship. Then it was an easy job to tow the airborne line across to Naruto on Shikoku Island on the opposite shore.

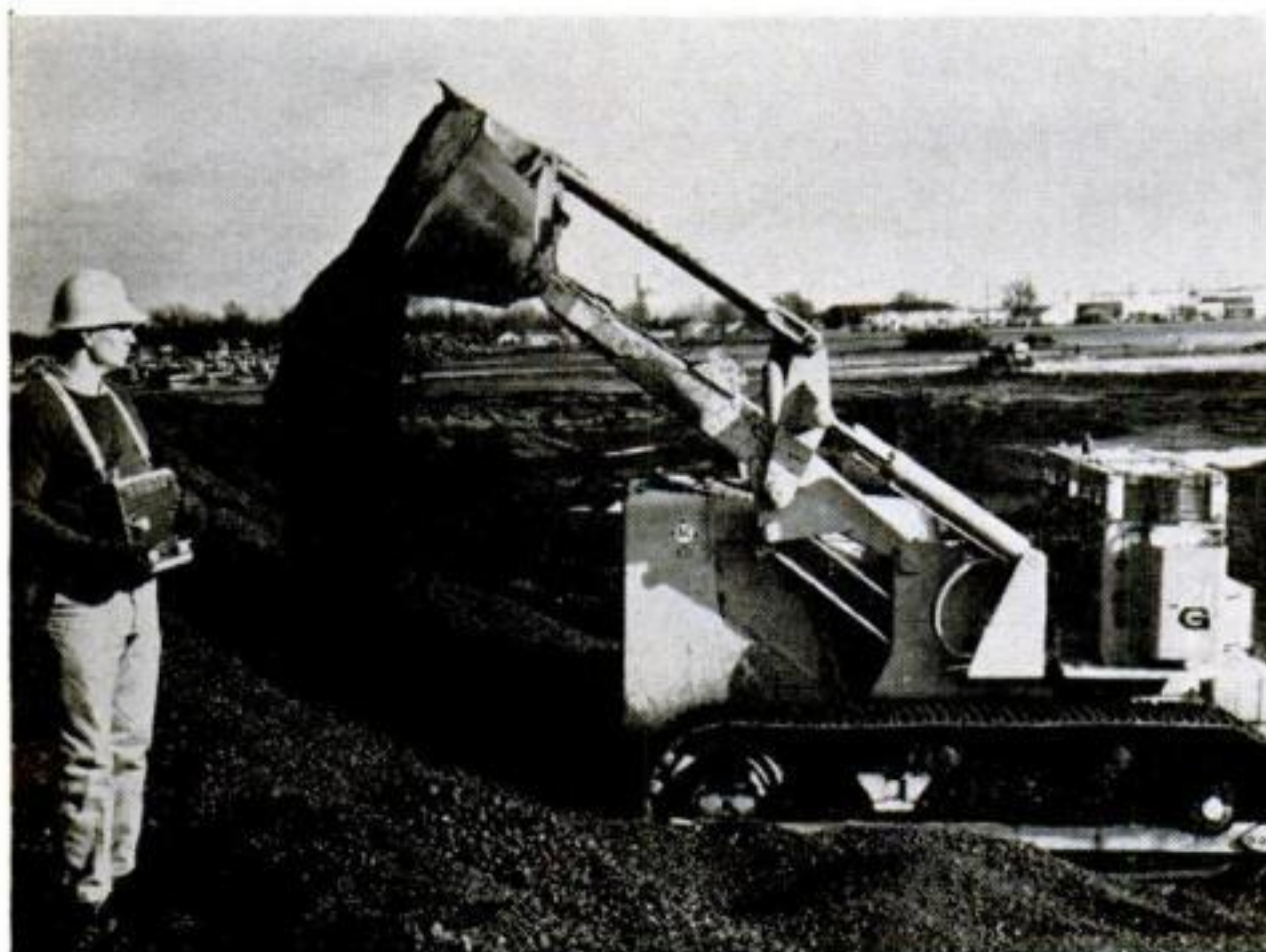


Nylon fabric of new Army armored vest covers overlapping plates of titanium.

New armored vest allows free movement

An improved armored vest of titanium plates stapled to tough nylon is being developed by the Army Quartermaster Corps at its Natick, Mass., research cen-

ter. The flexible covering gives a soldier greater freedom of arm movement than the multilayer nylon vest now in use and is expected to provide better protection.



Robot tractor to move hot slag

A radio antenna replaces the driver on a new remote-controlled crawler tractor and shovel. Allis-Chalmers built the 82,900-pound "Spook" for removal of hot slag in steel mills, handling radioactive materials, and other dangerous work.

The machine responds to radio signals from a panel strapped to a distant operator.



"Mother" of X-15 rocket plane in for checkup

Flight history of the North American X-15 is shown on the side of the "mother" aircraft from which the stub-winged rocket research plane is launched. The B-52B launching platform is in the Boeing plant at Wichita, Kan., for its periodic modification, inspection, and repair.

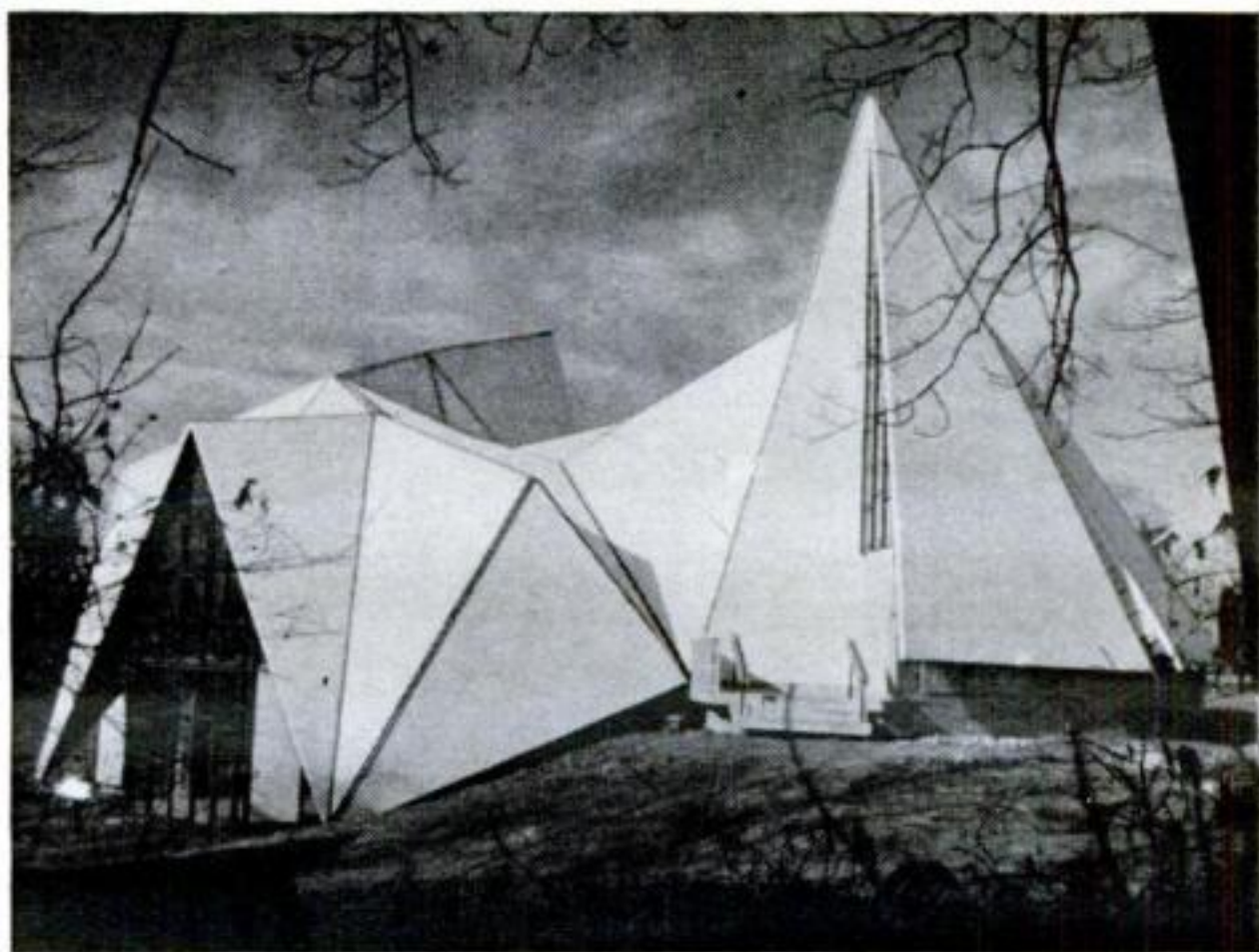
Horizontal rockets show how often the plane was carried but not launched; angled markings with split exhaust, flights powered by an XLR-11 engine; solid ex-

haust, with the larger XLR-99; and pods under the wing at upper left, the number of flights with automatic guidance. The larger bubble window at right is for the launch operator, the other for closed-circuit TV and two movie cameras.

Piloted by Major Robert M. White, the X-15 set a speed record of more than 4,000 m.p.h. and an altitude record of 217,000 feet, about 41 miles. It will soon try for 250,000 feet.

Church built of multiple triangles

Irregular triangles of varying size form the skin of the new United Church in Norwalk, Conn. The 42 panels range in size from 13 by 16 by 19 feet to 18 by 25 by 40 feet. They were fabricated by Cross, Austin & Ireland Lumber Co., Brooklyn, N. Y., of $\frac{3}{8}$ -inch plywood over a three-inch core of Dow styrofoam. The church seats 250.



BY CHARLES REMSBERG

What Happens When



You Call the Cops?



CULVER PICTURES

Suppose it's 11 o'clock and you're low on gas. You hope your regular station will still be open, but you find it's dark. As you start to pull away, your lights pick up three men stealing a wheel from a car parked next to the station. You get out fast, head for a phone to call the police. What happens

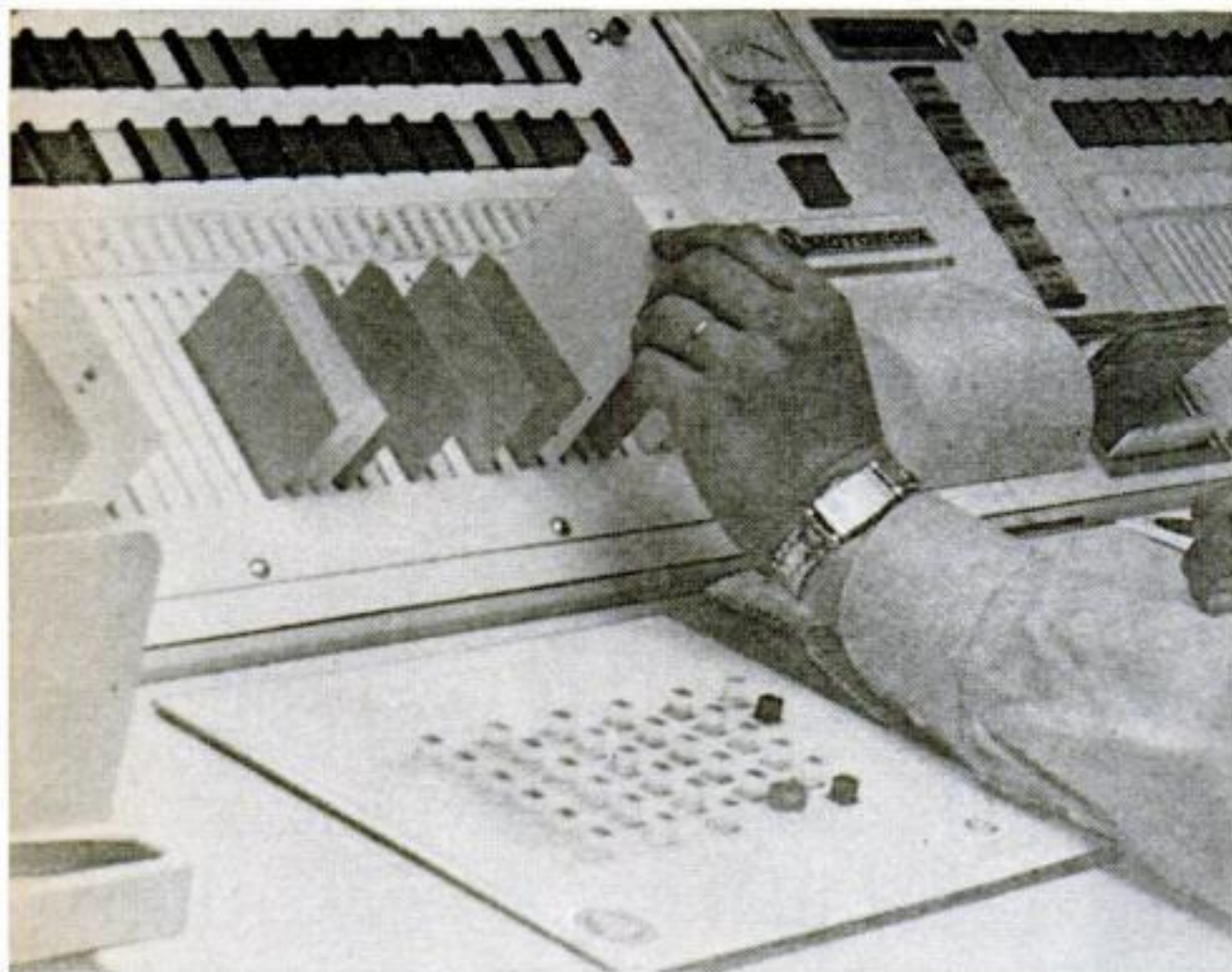


A FAR CRY from the antics of the Keystone Kops, police in big cities like Chicago direct chase of criminals with pushbuttons and computers.

CONTINUED

101

Trouble! You call the police and give your story . . . In



DISPATCHER ASSIGNS SQUAD CAR, puts complaint card in numbered slot. This turns out car's light on board, indicating vehicle is tied up.



POLICEMAN acknowledges assignment. Each car mon-

between the time your dime pings into the coin box and a cruising squad car pulls up?

If you live in Chicago, your report is processed by the world's most modern police-communications system—a \$2 million setup that uses 27 radio frequencies, 9 base transmitters with 3 satellite receiver stations, and 56 phone trunk lines.

Basic to this new crime weapon, designed by the late Ray Ashworth of the International Association of Chiefs of Police, is a unique tie-in with the city's network of telephone-exchange zones. A complex electrical-mechanical process detects the exchange from which you're dialing and channels your call to radio dispatchers whose zone of operation coincides with your exchange area. Not a second is wasted in getting your report to dispatchers who directly control police cars cruising near the area.

Three dispatchers for each of Chicago's eight communications zones are on duty around the clock. Each is seated before an elaborate console resembling a combination pinball machine and electronic computer. On each console's upright glass panel is a street map of the zone it controls, scaled from three to six inches

per mile, with police beats outlined. Numbered dots within beats represent police cars. If a dot is lighted, the car is available for assignment.

The action begins. Your call flashes on the pushbutton switchboard to the left of each dispatcher for your zone. Within 10 seconds, one answers on a jack headset and time-stamps an IBM-type complaint card. You blurt a brief description of what you've seen and the location of the service station. In the radio-equipment room across the hall from the communications center, your voice is being recorded on magnetic tape; it may be necessary, later, to refer to your exact words. The dispatcher pens what you tell him on the complaint card, then punches your call onto "hold."

After a glance at his map to find the closest available car, he touches a foot pedal. This allows him to broadcast directly to squads in the zone. With all conversation still being taped, he relays the assignment to the car he has chosen. A confirming reply comes back. Now a tight "triangle of control" has been established between you, a dispatcher, and a patrol car. The squad car races toward the scene of the crime.

minutes, a full-scale manhunt swings into action



itors two frequencies—one for its zone, one city-wide.

AT WALL MAP, communications officers can talk to any patrol car, and move disks on the map to keep track of a chase in progress.

As the dispatcher switches back to telephone reception to question you further, he passes the complaint card, time-stamped and marked with the number of the assigned squad, to the officer sitting at the center console for your zone. This policeman slips the card into a metal slot bearing the squad's number on his console turret panel. The card trips a switch to turn off the light behind the squad's dot on the street map, indicating the car has an assignment.

Twenty-four outside calls can be handled at once by the two rows of zone consoles and eight more by special consoles designed for overflow. More than 1,500,000 emergency calls will be processed this year. But this particular night, yours is destined to be the most exciting.

Within minutes, the officer assigned to the burglary is radioing his dispatcher startling news. "Those guys tried to shoot it out when I drove up . . . grazed me twice . . . got away in a '58 Olds . . ."

Emergency! The dispatcher presses a button on his right to light a red bulb atop his console. This alerts the entire communications center to an emergency.

Then he punches a switchboard button, opening a direct line to the fire-

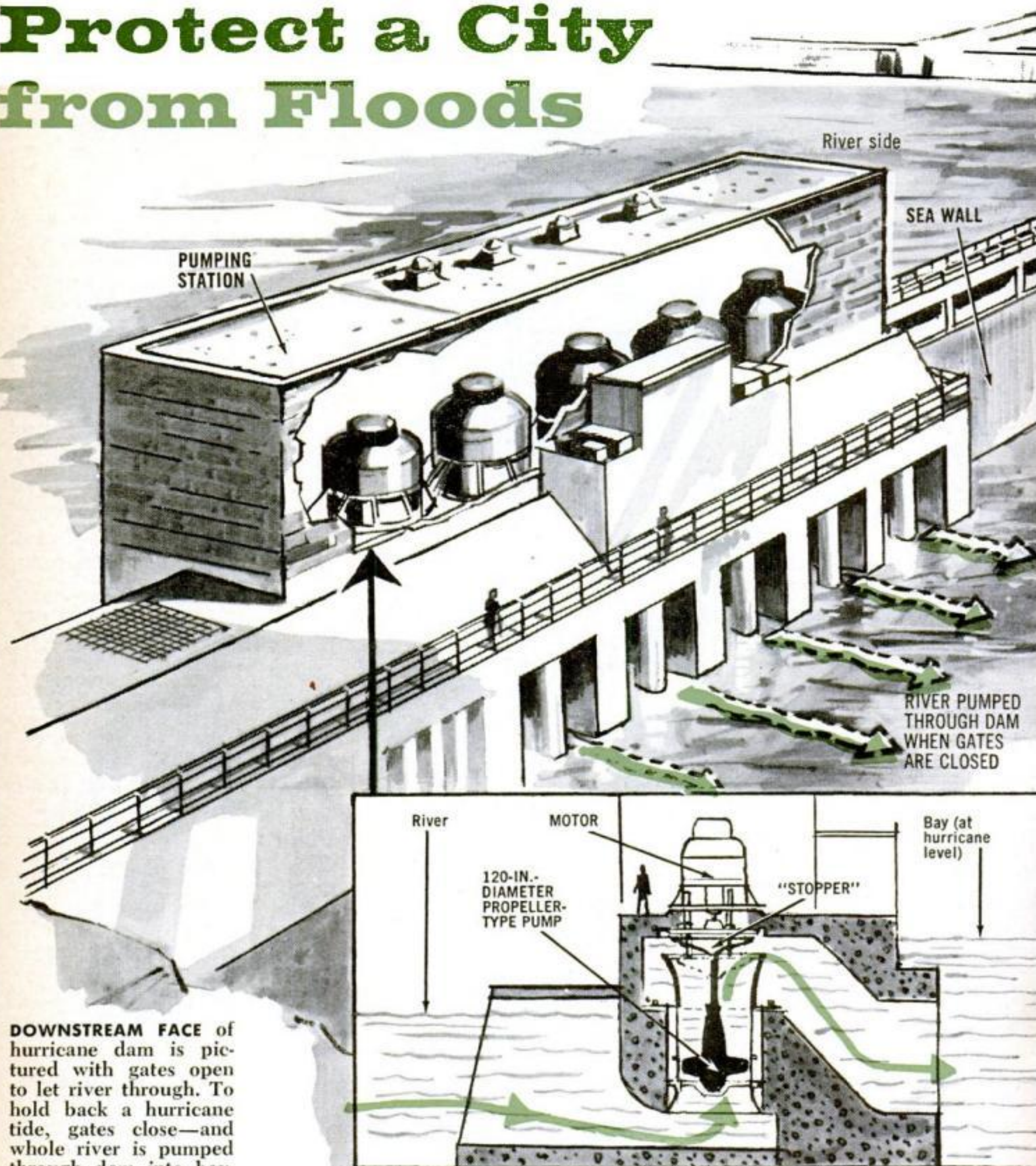
alarm office, which controls the city's ambulances. With an ambulance on the way, he switches to the center's intercom and notifies the operator of one of six city-wide consoles. These units, operating on three different city-wide frequencies, contact detectives and other personnel not under the jurisdiction of zone frequencies. Banks of buttons—500 in each—represent vehicles in the field and, like the dots on the zone dispatcher's map, are lighted to indicate service status. The city-wide dispatcher answering the intercom call sends a car to investigate the shooting and report on the wounded officer's condition.

Then, again by intercom, the zone dispatcher who took your call alerts the center's "point-by-point" console to stand by for an urgent "all-call" message. The point-by-point can radio every police car on duty on a single, city-wide frequency that each car receives in addition to its zone frequency. The console also can broadcast to 150 municipal, county, and state police units within a 50-mile radius.

Back on his own frequency, your zone dispatcher jots down the injured policeman's description of the getaway car, in-

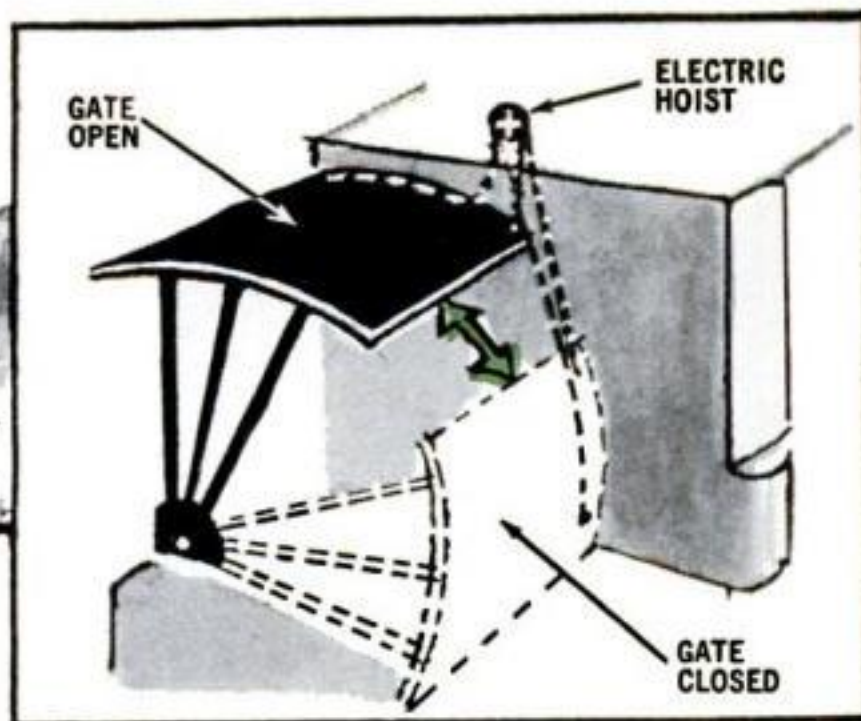
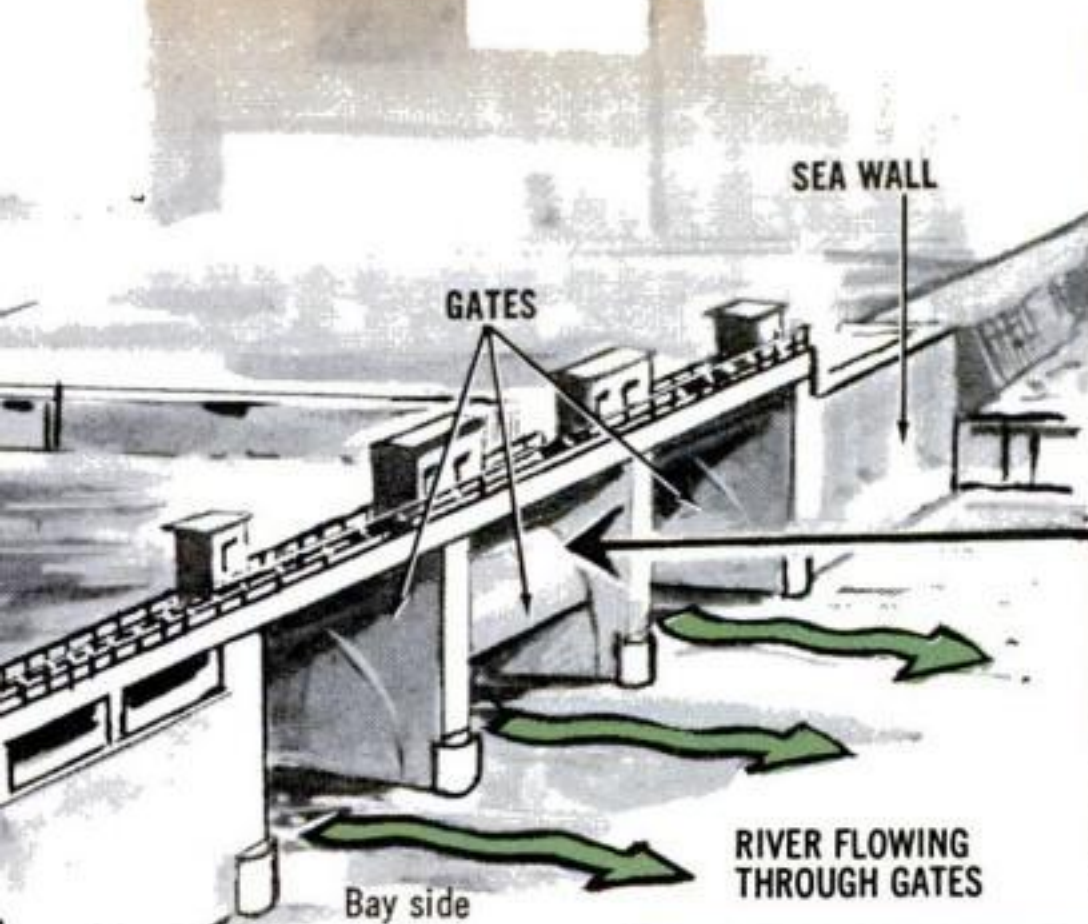
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Hurricane Dam to Protect a City from Floods



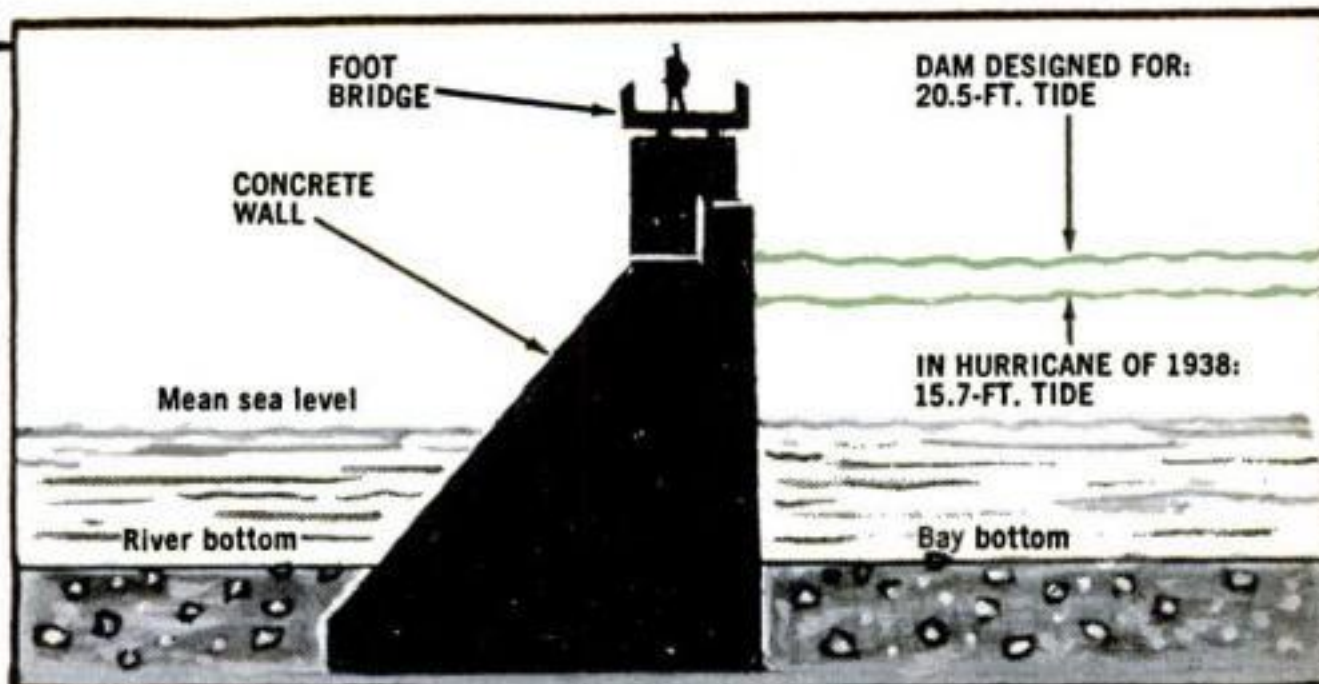
DOWNSTREAM FACE of hurricane dam is pictured with gates open to let river through. To hold back a hurricane tide, gates close—and whole river is pumped through dam into bay, by pumping station in foreground, until the abnormal tide recedes.

BIGGEST IN THE WORLD, five pumps like this one can pump river “uphill” against head of 20-foot hurricane tide, exceeding worst in modern times. Hydraulically operated “stoppers” could close outlets against sea in unlikely event of a still-higher tide.



THREE GATES like this, in usual raised position, give 25-foot vertical clearance for river craft. Lowered for hurricane (dotted outline), the gates seal the 40-foot-wide openings.

CONCRETE SEA WALL has this shape. Atop is foot bridge between pumping station and river gates. Markings compare highest sea of modern times, 15.7 feet above mean sea level in 1938 hurricane, and 20½-foot rise for which dam is designed. Six-foot rise was enough to begin damage to city.



A sea wall, gates, and pumps that swallow up a whole river will save Providence from inundation by gale-whipped seas

By Alden P. Armagnac

WHEN hurricane winds push the sea as high as 15 feet above its normal level, hardest-hit of any northeastern U. S. city is Providence, R. I. The city's low-lying downtown area, straddling the tidal Providence River, has been flooded three times in 25 years—with damage that would total \$75,000,000 at current prices. Soon, however, the disastrous floods will be ended, by the country's first hurricane dam.

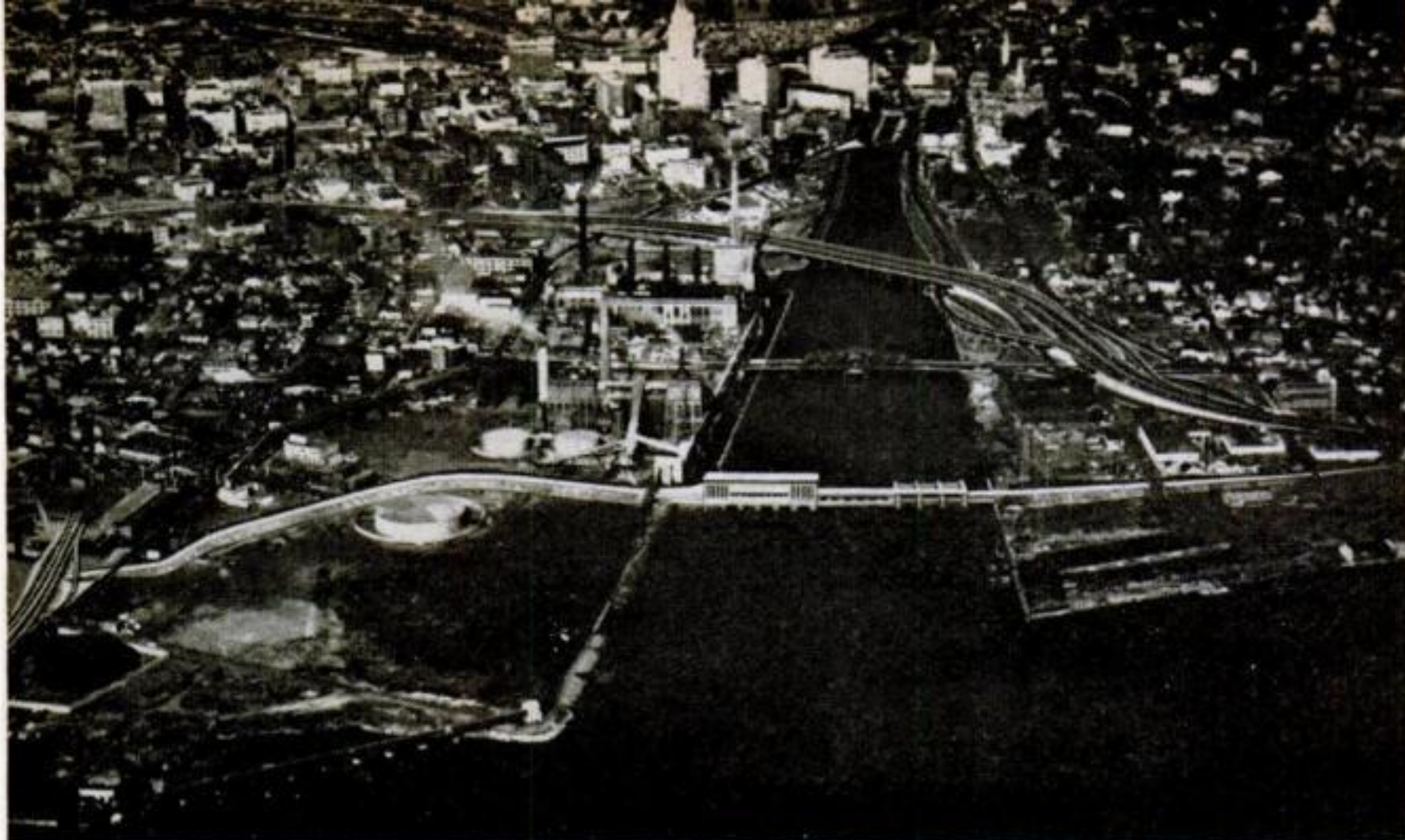
Now under construction across the river's mouth, the 680-foot-long dam combines a concrete sea wall, river gates, and a mighty pumping station.

Rising 25 feet from its normal water

line, the sea wall is designed to fend off a hurricane tide reaching a phenomenal height of 20½ feet above mean sea level as it funnels up Narragansett Bay.

Gates at three openings in this barrier will usually be raised—allowing the river to flow through, and small craft to pass. At a hurricane's onset, lowering the gates will seal the wall.

Pulling the cork. How about the bottled-up river, which keeps right on coming? The answer is to pump the whole river through the dam, with the built-in pumping station. That amounts to propelling the river uphill, against the "head" or back pressure of the sea's higher level. Five gigantic electric pumps, the world's biggest, will discharge the re-



LOW-LYING STREETS of downtown Providence border wedge-shaped mouth of tidal Providence

River. New dam and adjacent dikes, drawn in on aerial photo, will protect city from sea.



SEVEN FEET OF WATER swamped Providence in 1954's Hurricane Carol (photo), eight feet in 1938 hurricane. Preventing one such flood could avert \$32,500,000 to \$42,000,000 damage.

quired total of more than 3,000,000 gallons a minute into a sea 20 feet higher than the river.

Past experience has shown that the emergency period until a hurricane tide recedes may be as short as four hours. Then the pumps can stop and the gates can reopen.

To safeguard the pumps' power against failure, it will come underground—by two separate circuits, either one ample, from a nearby substation. The gates, remotely controlled from the pumping station, share this power supply.

Plugging the bottle. If the crest of a hurricane tide exceeded even the designed-for maximum—an unlikely event—hydraulic “stoppers” would close the pumps' outlets. Letting the river rise briefly would cause only minor flood damage compared with the threat from the sea.

Lest a rising sea outflank the dam, its ends will be prolonged inland by rock-armored earth dikes. Openings in the dikes for waterfront streets can be sealed with swinging steel doors.

Due to be completed in 1964 by the U. S. Army's Corps of Engineers, for operation by the city, the dam should be far enough along by next year for use in case of need. It will more than repay its \$17,000,000 cost in a single hurricane like that of 1938 or 1954. ■ ■

An armchair for lazy fishing

A floating chair designed originally for lolling in a swimming pool has now been adopted by fishermen.

Arms and footrest are buoyant polystyrene foam, the frame is aluminum tubing, and the seat is plastic webbing. The footrest can be detached and used as a headrest instead. The Floater-Loafer is made by Madison Precision Industries, Inc., Madison, Ind.



Air-to-ground refueling

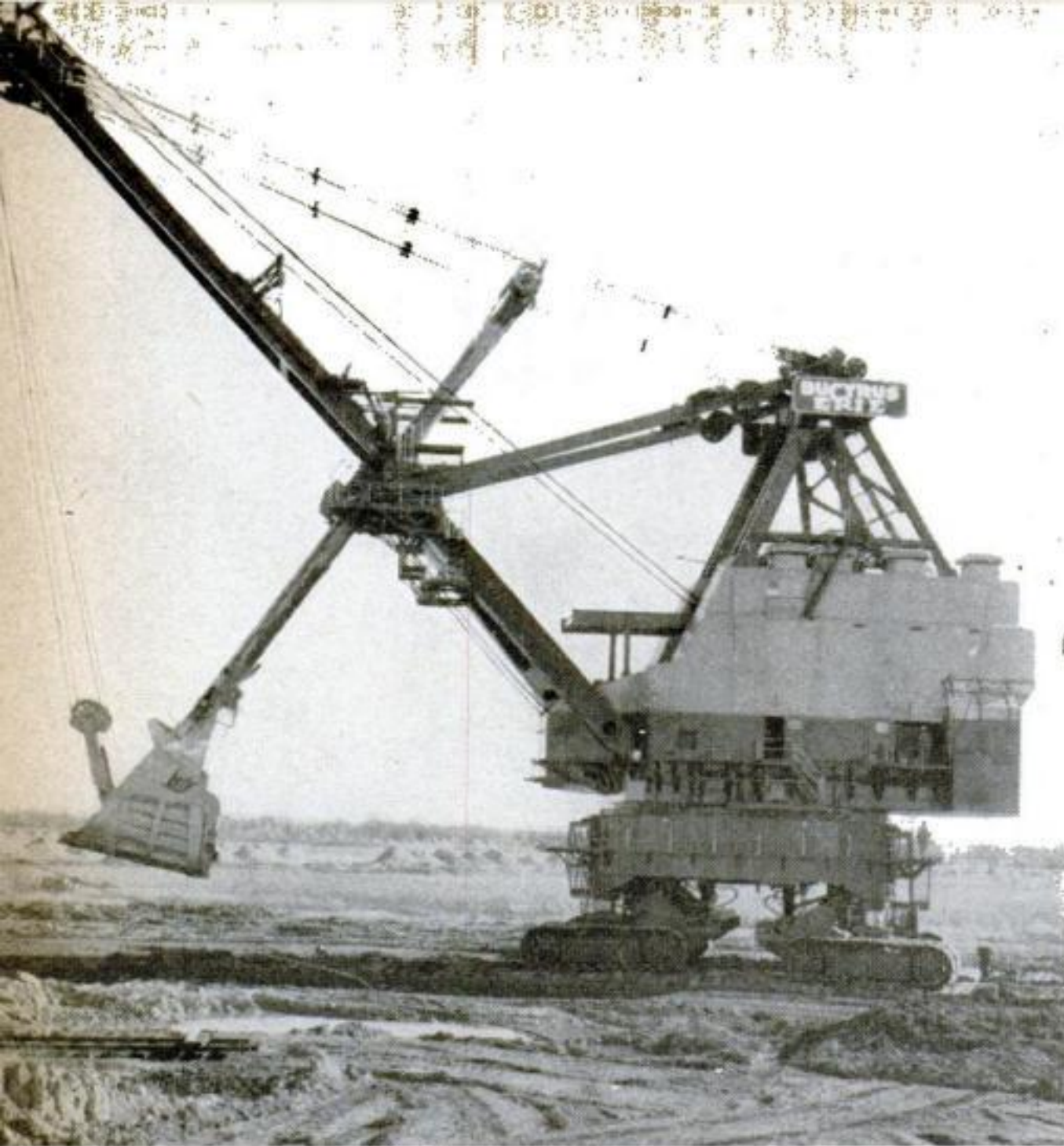
On-the-spot refueling, now routine for aircraft, has been taken a step further by the Marine Corps. It is testing a new air-to-ground refueling technique at the Quantico, Va., base. Here a tanker helicopter refuels an infantry tank while hovering 30 feet overhead.



Dialing a number unlocks door

No need to carry a key if you install one of these new Swedish door locks, but you'd better have a good memory.

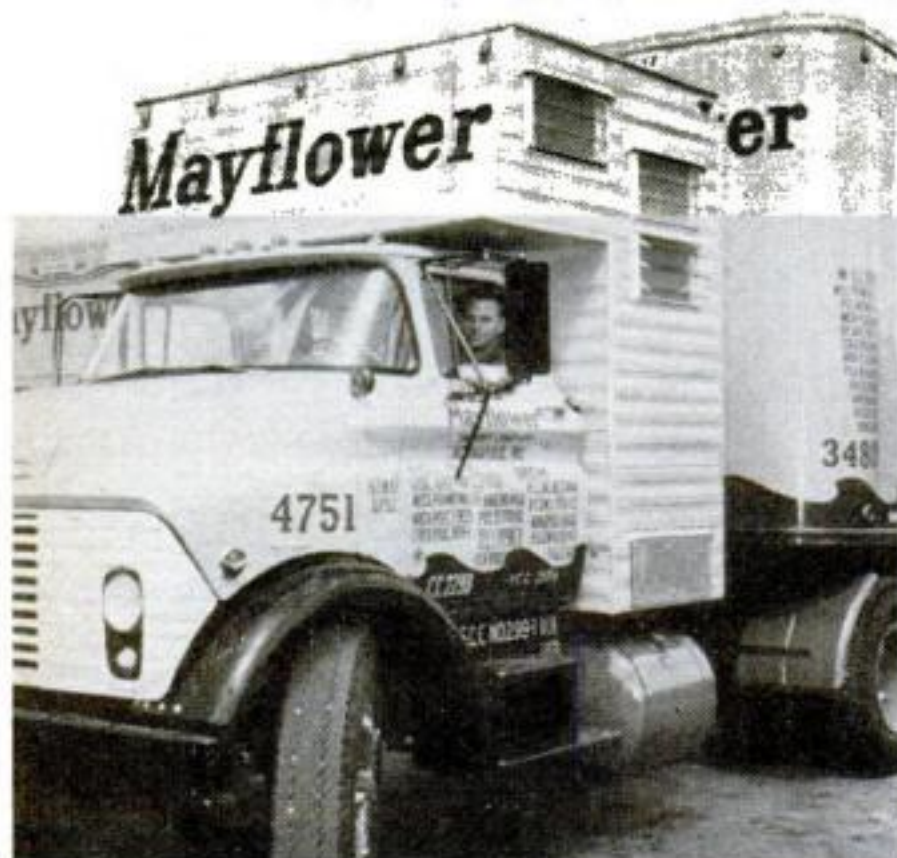
The lock works electrically. To open it, you press five numbers on a dial. The code can be changed by rearranging contact plugs in a relay box inside the house.



Coal-mine shovel 12 stories high

This 2,600-ton stripping shovel at left was delivered piece by piece in 100 railroad cars and reassembled at the Fidelity Mine of the United Electric Coal Co. near DuQuoin, Ill. It scoops up 70 cubic yards at each bite, is powered by 6,000-volt electricity, and towers taller than a 12-story building.

The giant Bucyrus-Erie shovel is said to be the largest now being worked, slightly outclassing the huge Peabody mine shovel at nearby Freeburg, Ill.



Compartment behind and on top of cab contains chest, seat, table, and bed.

Camper built over truck cab

Because he drives 60,000 miles a year as a cross-country contract truckman, Charles E. Rasmussen of Dulzura, Calif., takes his home and office with him. It's the only one of its kind in the Aero Mayflower Transit Co.'s moving-van fleet. Rasmussen sketched requirements for

Van Bibber Co., Indianapolis manufacturer of campers for pickup trucks. Exterior of the office-sleeper is aluminum, interior is oak paneling. In it are a chest of drawers under a cushioned seat, a folding table, a bunk over the cab roof, and two lights, one in the ceiling and one in the wall for reading in bed. Under the floor is a compartment for tools.



Variety store on wheels

A modern, air-conditioned bus equipped as a store is making the rounds in outlying districts around Orlando, Fla. It was built for McCrory Corp., which operates a number of chains including the McCrory, McLellan, and H. L. Green stores. Others are expected to follow in other parts of the country.

The Shopmobile has a 35-foot-long, 8-foot-wide body on a GMC chassis, and is driven by a rear-mounted 210-hp. V-6. Goods are displayed on wire racks that won't let them spill into the aisle when the bus is on the road. Customers enter through a rear door, leave at front, passing by a cashier and checkout counter on the way out. The bus is also equipped with front and rear tow hooks, exterior floodlights, a public-address system, two-way radio, and a 10,000-watt generator that can furnish power to a hospital in a community emergency.



Mobile shoe-repair service

A cobbler in Detroit doesn't wait for customers to come in. He goes to them. Shoemobile, Inc., operates a fleet of Cushman trucksters to pick up shoes at customers' homes and bring them in for repair. The mobile units are built up of cloth and plastic to resemble a Mother Goose shoe and topped with an elflike figure. Each driver also carries a stock of polishes, laces, and other supplies.





Kidnapped

**Famous Civil War engine
—stolen by the Yankees to
raid the Confederate supply
lines—has been resurrected
for a commemorative run**

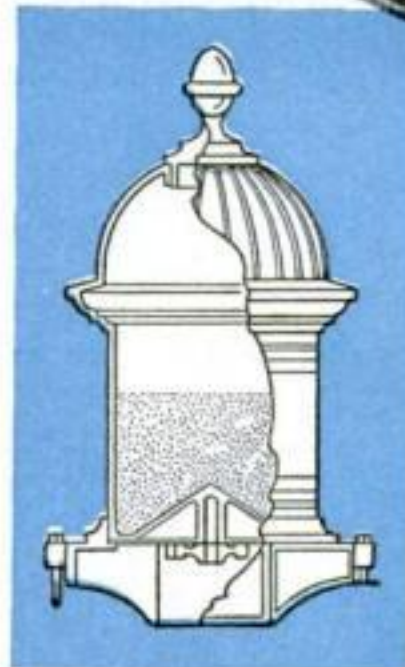
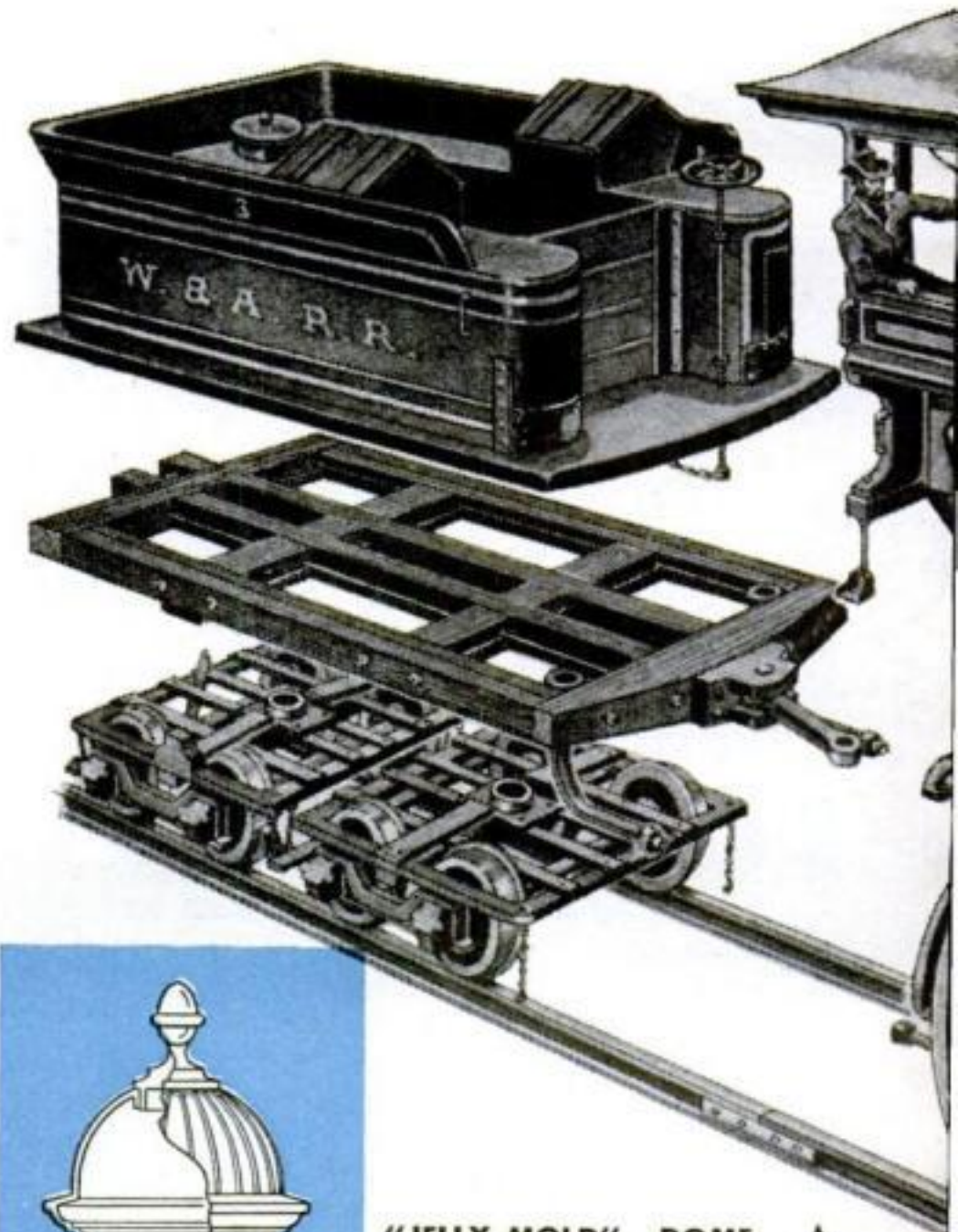
By Henry B. Comstock

THIS April 14th, a 107-year-old steam locomotive will chuff over 87 miles of high iron deep in the heart of Dixie. Fast freights will take siding for her. Diesel horns will bray as she whooshes by, her slender rods dancing to the tune of 140 pounds of saturated steam. Behind her, an ancient combine coach will be packed with VIPs. An accompanying excursion train will give camera fans the chance of a lifetime to photograph the balloon-stacker in action.

All this will add up to one of the highlights of the Civil War Centennial's second year—the commemorative run of the history-making locomotive, the General.

Things were different when the little engine traveled the same route on another Saturday 100 years ago. Less than 30 miles above Atlanta that April 12th, the General was kidnapped by 20 Yankees. Led by Union Secret Service agent James J. Andrews, they planned to highball the woodburner up Western & Atlantic track, ripping out rails, burning bridges, and destroying the telegraph line. That would leave the Confederate army defending Chattanooga without a supply route.

But they hadn't reckoned on the Rebel conductor, William A. Fuller. Caught off guard when his coaches were uncoupled and the locomotive steamed off, he and some volunteers chased the raiders on



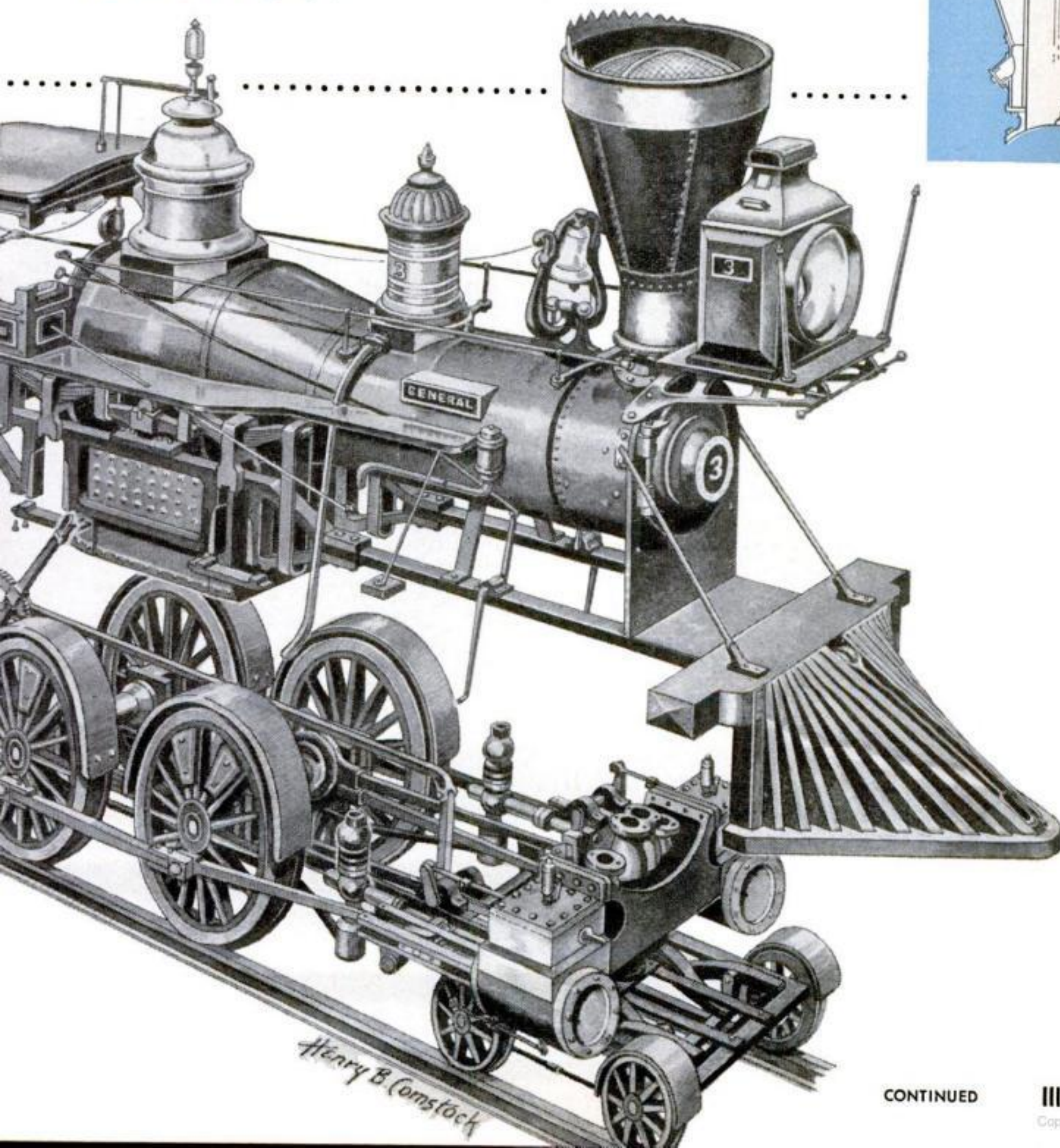
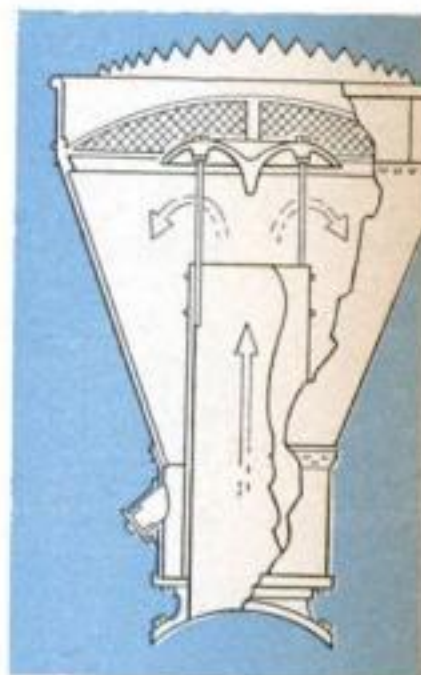
"JELLY-MOLD" DOME: A century ago, small boys could tell the make of any locomotive by its domes. The General's sandbox is still capped by one of the fluted hemispheres that marked her Yankee builder—the Rogers Locomotive & Machine Works.

Locomotive to Ride the Rails Again



BOX HEADLAMP, nearly four feet high, shed little light. Of similar lamp, an engineer once wrote in his trip report: "Saw the Shadow of Death preceding us. Stopped, removed moth from lens."

BALLOON STACK did double duty as chimney and spark arrester. Fiery particles, blasted up inner stack, struck deflector plate or wire-mesh bonnet above it and tumbled to base of outer stack.

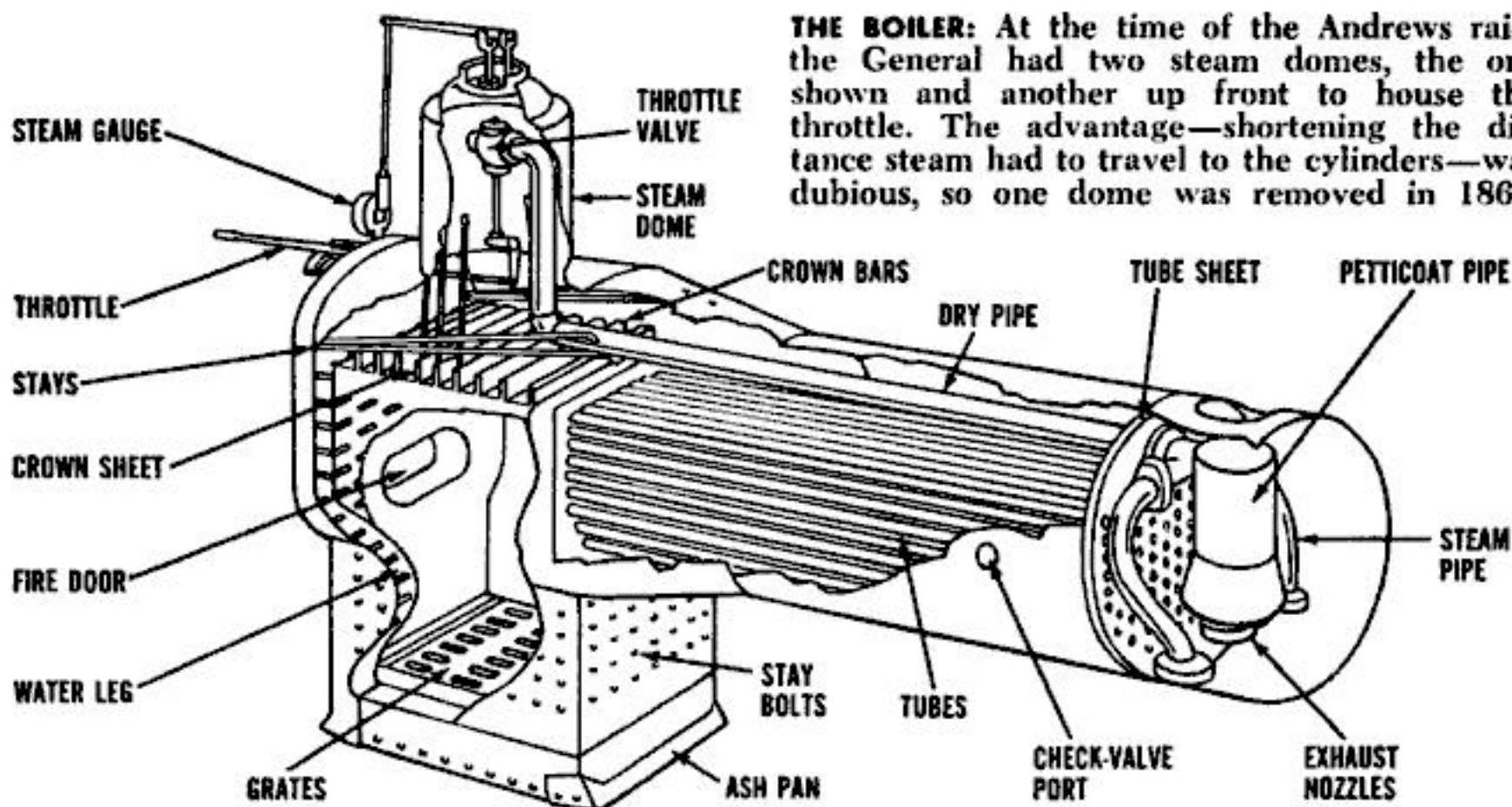


Henry B. Comstock

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III

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THE BOILER: At the time of the Andrews raid, the General had two steam domes, the one shown and another up front to house the throttle. The advantage—shortening the distance steam had to travel to the cylinders—was dubious, so one dome was removed in 1868.

foot, on a push car, and finally with a succession of three commandeered locomotives.

Desperate stoking kept the General out in front until her fuel and water gave out. The raiders, forced to abandon her, were quickly rounded up. Andrews and seven others were hanged.

The story of the dramatic raid has been told in books, a play, and two movies. Civil War buffs know that a fair amount of fiction has been spooned into these thrillers. But it isn't so widely known that the General herself has been innocently spoofing the public for 70 years.

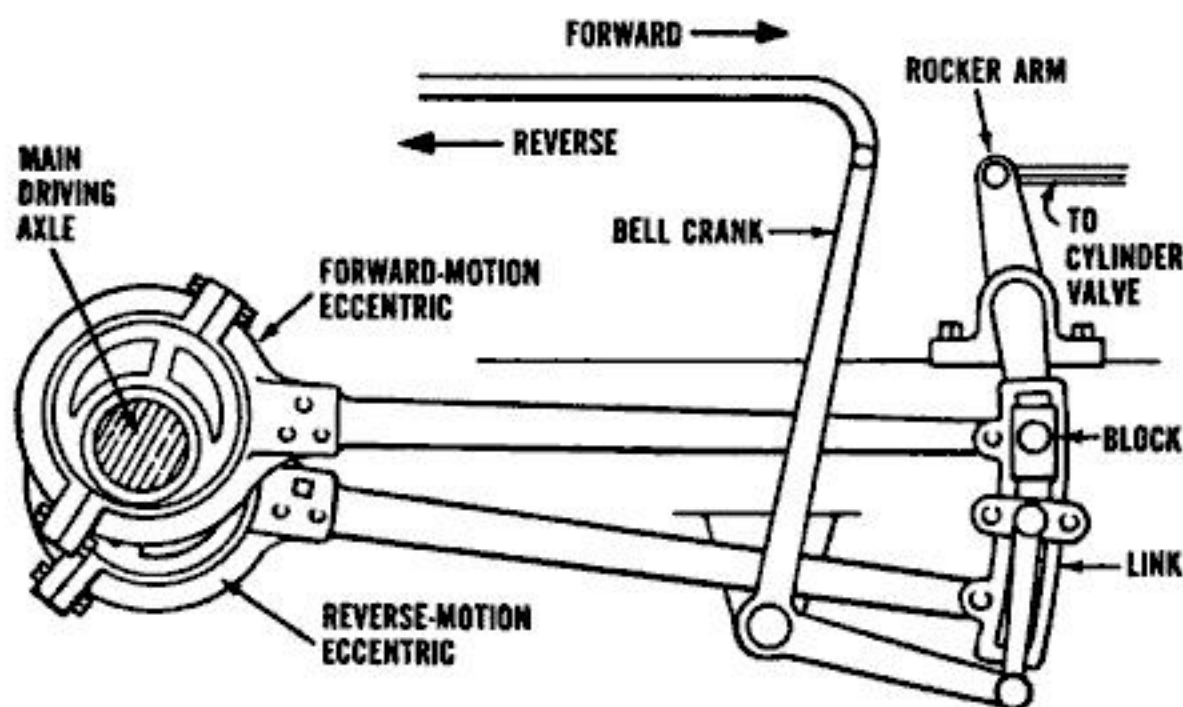
Somebody goofed. In 1891, the doughty locomotive was hauled off a graveyard track and prettied up for display in Chattanooga's Union Station. She came out of the shops looking little like the

quaint General of Civil War days. She now resembled the handsome locomotive she had become in 1868, when the Western & Atlantic modernized and converted her into a coalburner. To disguise the anachronisms, some cordwood was heaped in her tender and she was given a reasonable facsimile of her original balloon stack.

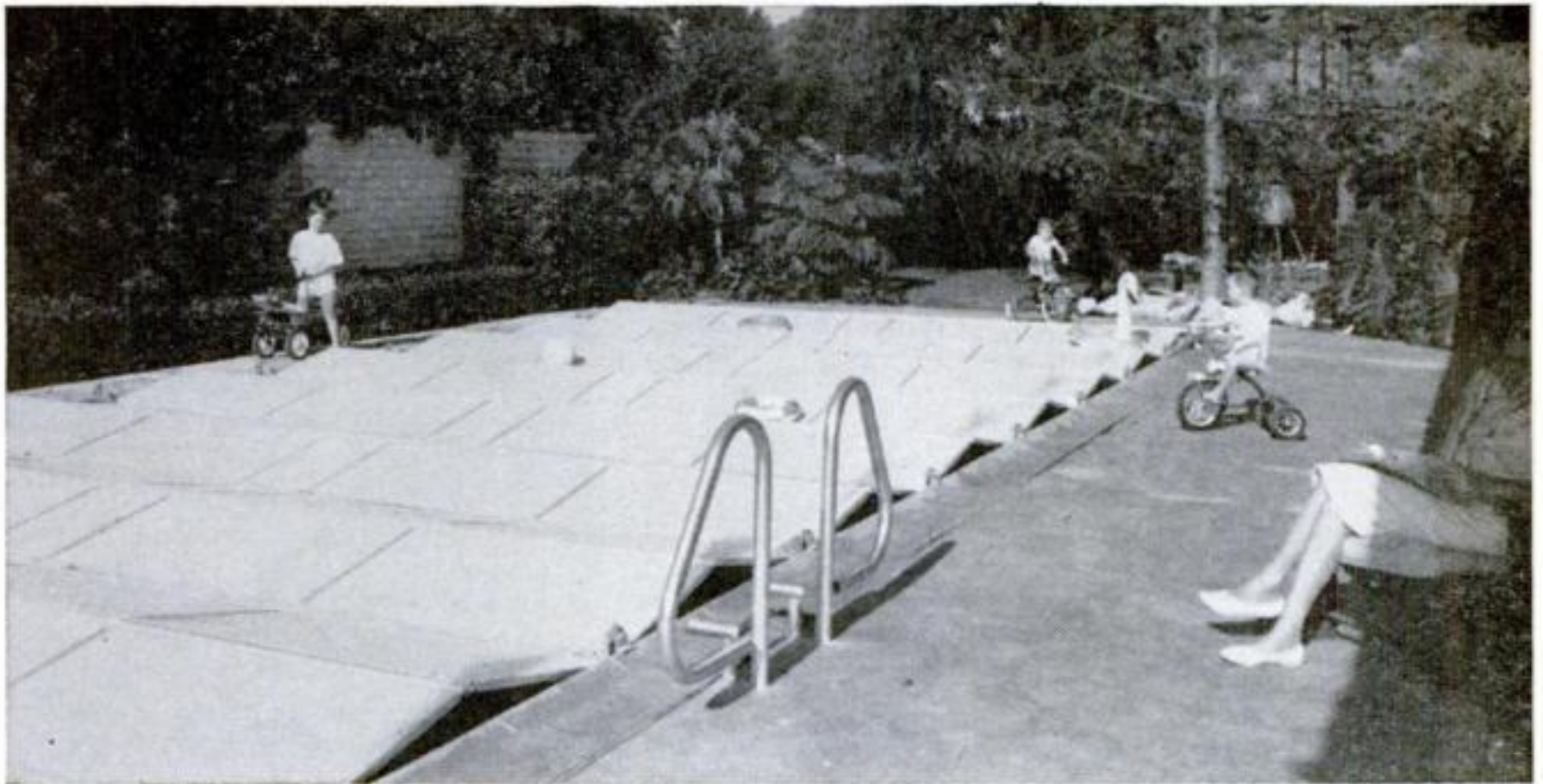
When the Louisville & Nashville R.R. (operator of W&A under lease) decided to put the General back in working order for the coming ceremonies, they knew all about her shortcomings. They also knew that it would be easy to correct them. But there was a hitch: Millions of Americans have seen and admired the exhibition engine, not only in Chattanooga, but at seven national expositions.

To do a reverse face-lifting job on the

[Continued on page 216]

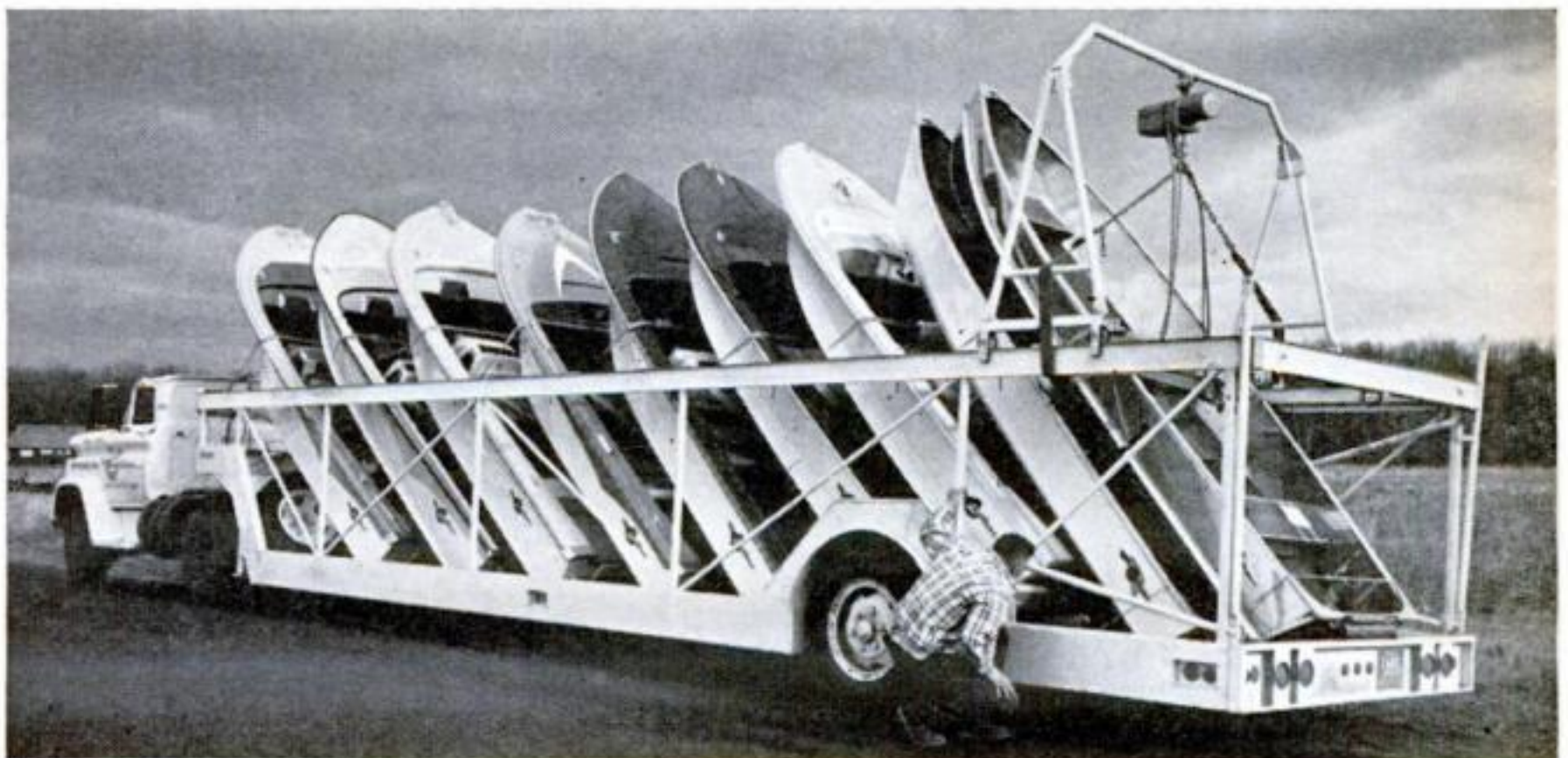
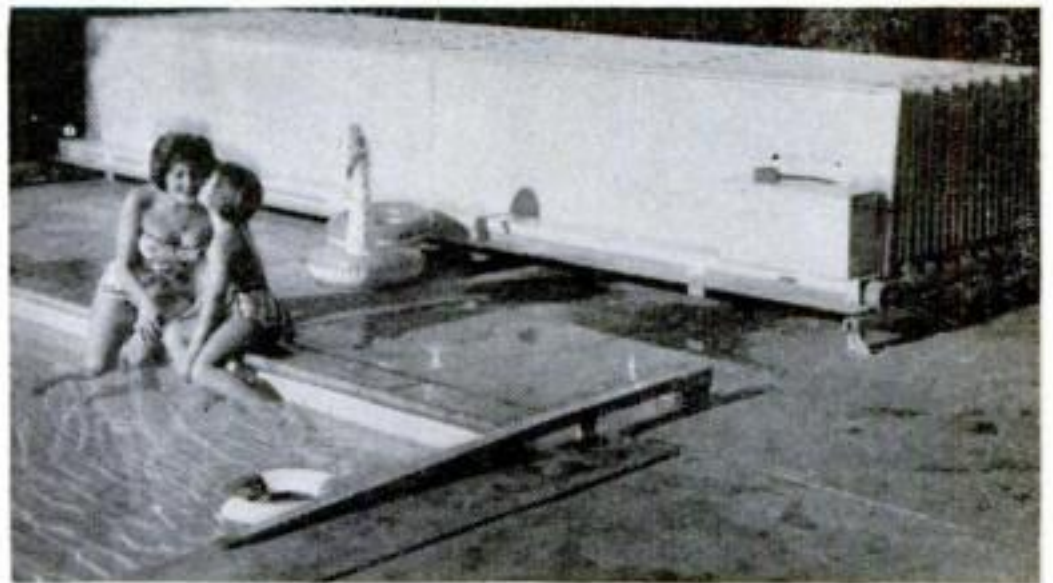


VALVE GEAR on the General was as simple as the transmission on a Model T Ford. When the engineer shoved a lever forward, he lowered a pair of links, delivering to the cylinder valves the motion of eccentrics set for forward running. With the lever hauled back and the links raised, the reverse eccentrics shuttled the valves in the opposite sequence. By shifting the lever toward center, less steam was admitted to the cylinders, giving better performance at high speeds. Before air brakes came along, reversing was relied on for quick stops.



Safety hatch keeps swimming pool private

A metal cover locks over this swimming pool near Los Angeles to keep unwanted guests out and unwatched children from falling in. Hinged panels move on rollers along side rails, fold at one end when pool's in use. It's opened and closed by a switch cord that can be removed to lock cover on.



Self-loading boat trailer

A power winch, riding on rails and controlled by pushbutton, lets one man hoist boats onto a new 37½-foot trailer. The

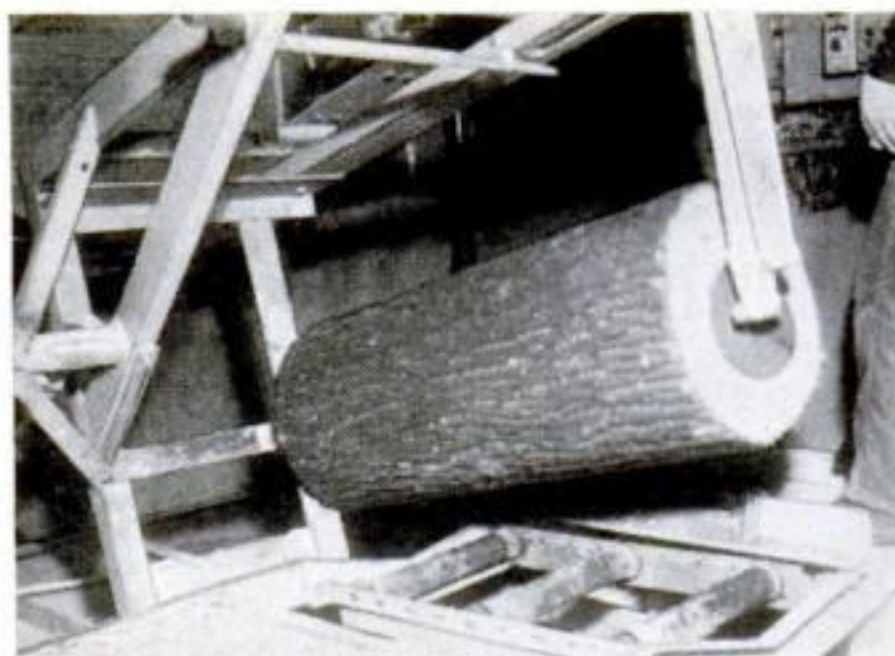
boats, headed for dealers, are stacked at an angle, the weight of each resting on cushioned spacers at stern and midship. The trailer was designed by Crestliner, boatbuilders of Thompsonville, Conn.

Sawing out blanks for baseball bats

Why so many home runs today? Many fans and baseball players—including Roger Maris—think it's due to a better bat, not a livelier ball.

That may be open to argument. One sure thing, however, is that new machinery at the Larimer and Norton, Inc., plant in Akeley, Pa., has improved one operation. It turns out ash billets faster for finish turning by bat manufacturers.

A cylinder, or barrel, saw cuts out "raw bats" automatically, eliminating log splitting and preliminary lathework. The photographs show how this early manufacturing step is done.



1. SAWED LENGTH OF ASH LOG, fed on rollers, is clamped between pivots and then up-ended for sawing out billets.



2. CYLINDRICAL SAW, revolving at 1,500 r.p.m. under hydraulic pressure, bites through.



3. GIANT DOWEL is sawed from the resilient sapwood. Billet will become turning blank.



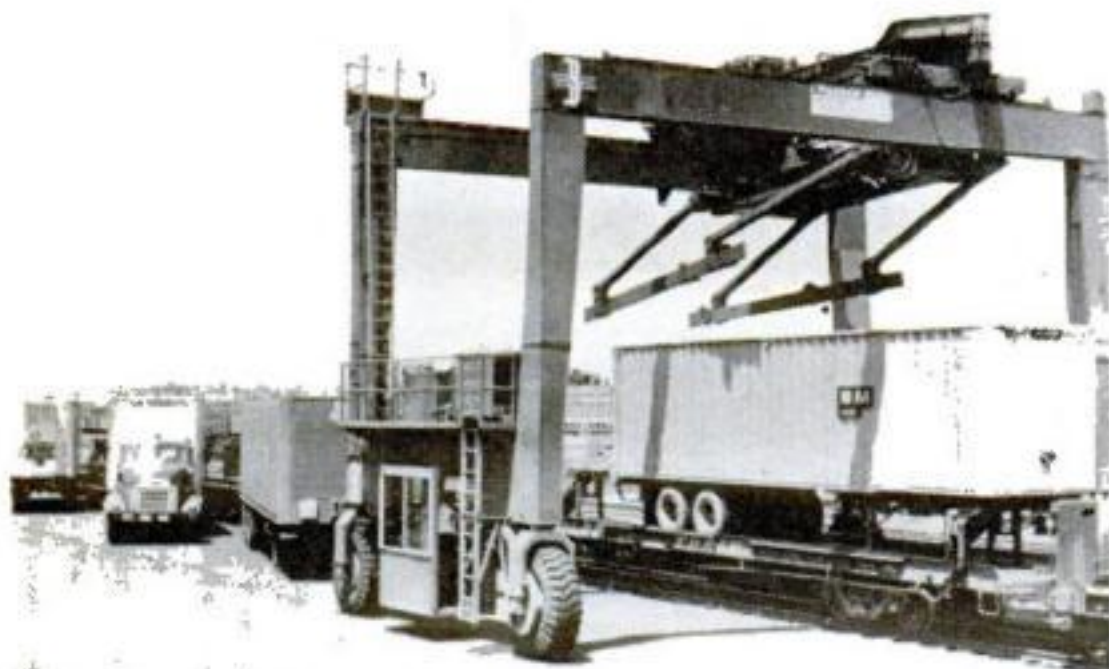
4. EIGHT "RAW BATS" come from each log. Hard heartwood at center and bark are unused.

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Giant train straddler

A 75,000-pound rubber-tired rig, 35 feet wide, plucks piggy-back trailers from flatcars and lines them up at an angle so they can be hitched to tractor trucks and hauled away without jockeying.

Two of the TransTainers speed unloading in the Boston freight yards of the Boston & Maine Railroad. Straddling a track, one of the big lifts can unload a trailer from a mid-train car in 90 seconds. Without it, the train would have to be broken up and the trailer unloaded on a ramp.





5. PACKED PALLET stores from 150 to 225 smooth, round ash billets that will be shipped to factories in Kentucky and elsewhere for final

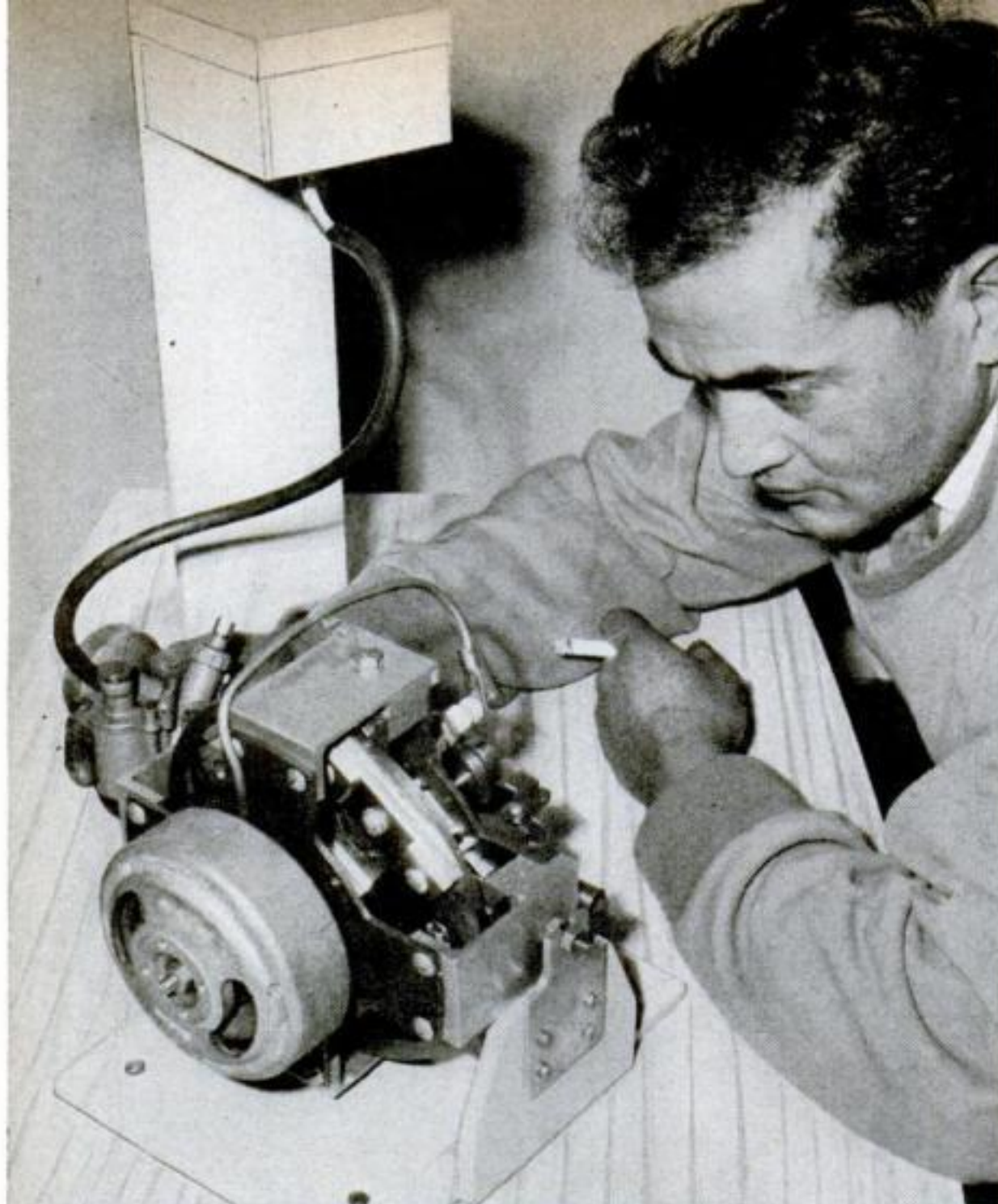
turning. Only perfect wood is used for making baseball bats. Imperfect seconds are sold to novelty and croquet-mallet manufacturers.



Detachable pontoons convert trailer into houseboat

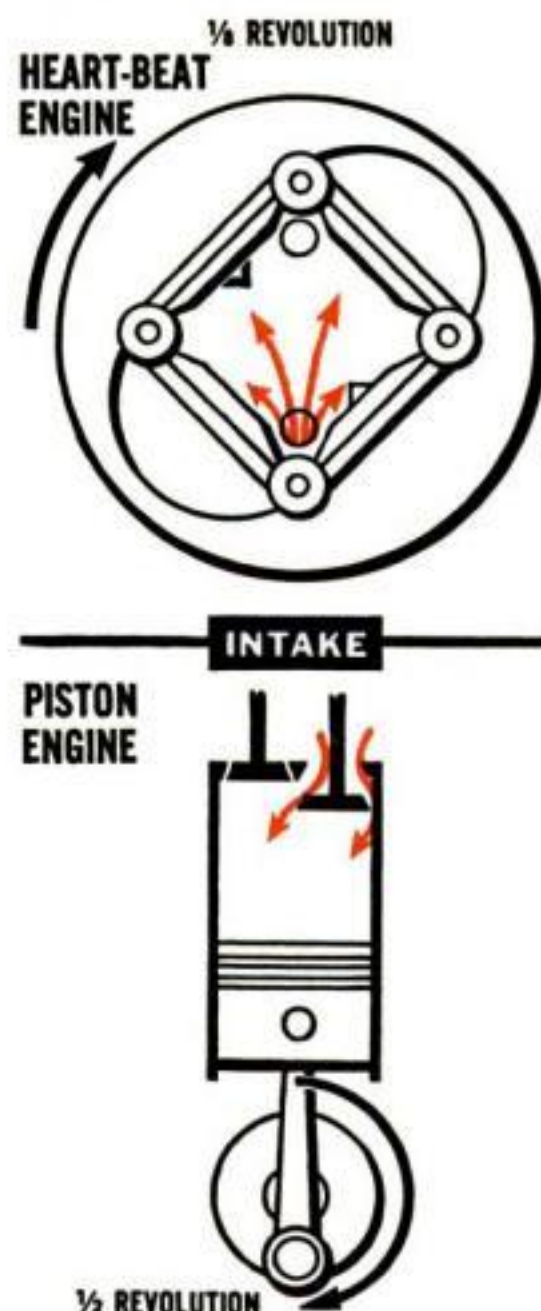
A new Australian trailer takes to water like a duck. At lakeside, 20-foot pontoons are lifted from the roof and bolted to the edge of the 7-by-12-foot mobile home.

It's then backed into the water, the undercarriage is unbolted, and fore and aft decks and an outboard are attached. The amphibian home has berths for four.



INVENTOR RAJAKARUNA built working model with hand tools on the kitchen drainboard. It displaces four cubic inches, has a 5:1 compression ratio. Central shaft runs through (from left) magneto, cam plates, box cylinder, and head carrying plug and valves.

Diagrams show how



Heart-Beat Engine

A new auto engine that needs no gearbox? Maybe—with this folding-box cylinder that delivers high torque at low speed

By David Scott

A STRANGE new engine with neither rotor nor pistons is challenging conventional engine designs. It is a hinged box that pulses like a beating heart. The box just folds flat and opens, its hinge pins turning a cam fastened to the output shaft.

The idea was dreamed up by a young Ceylonese aircraft engineer, Eton Rajakaruna, who now lives in Hull, England. He claims rather impressive advantages for auto power plants: The pulsing box

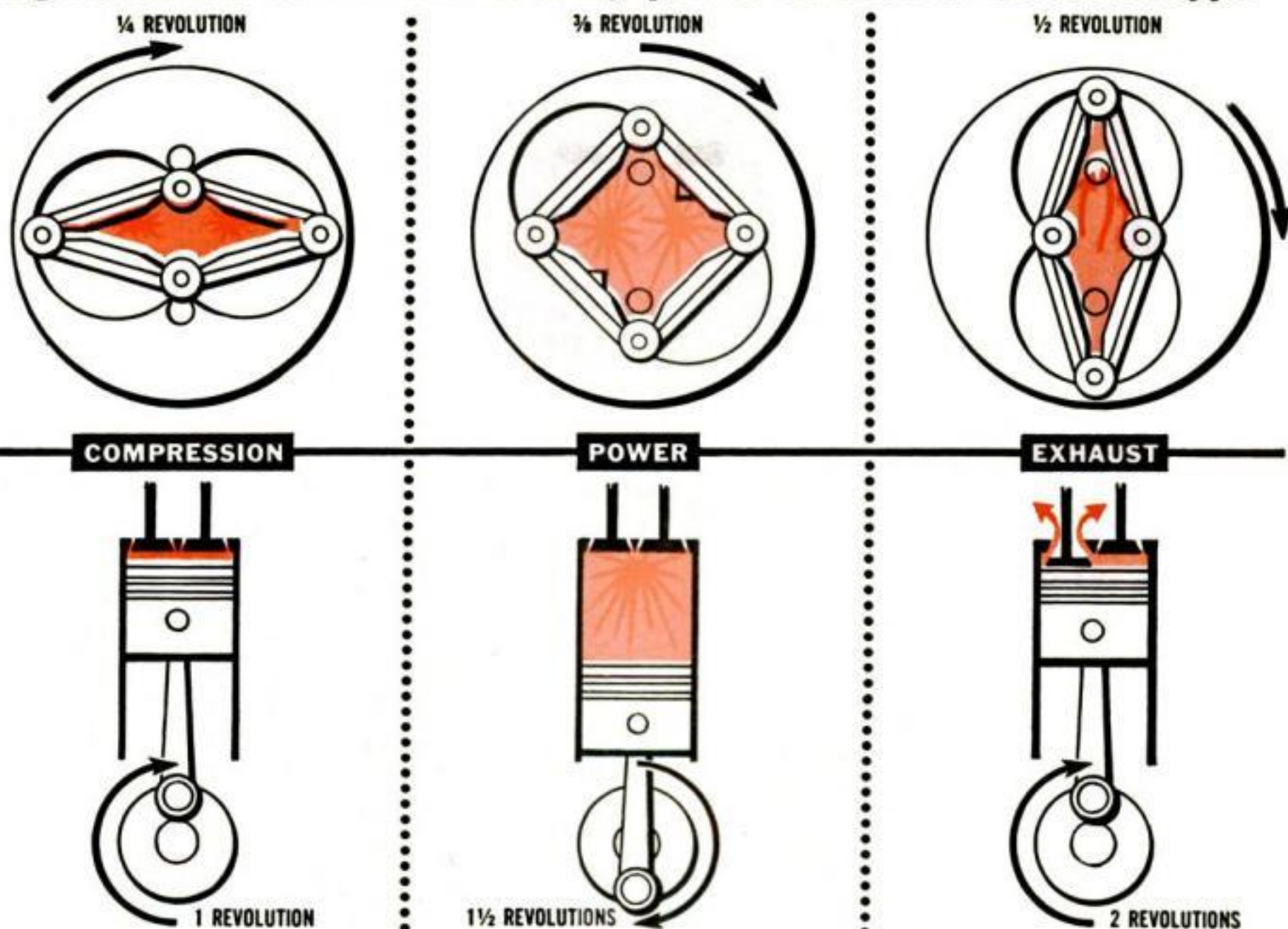
delivers high torque at low speed (like a steam engine), so the gearbox might be eliminated or, at least, simplified.

It has two power strokes for every shaft revolution—twice what you get from a two-stroke engine, four times what you get from a four-stroke. That means more horses from less bulk and weight.

It has few moving parts. All parts are simple and should be cheap to make—they might be stamped out almost like tin cans.

Explosions are contained in a symmetrical envelope, and all moving parts are

engine makes four times as many power strokes as standard type



LIKE ORDINARY AUTO ENGINE, heart-beat type follows four-stroke cycle of intake, compression, power, and exhaust. However, heart-beat engine runs through cycles twice for each revo-

lution of output shaft, while standard engine needs two revolutions for one cycle. Increase in power impulses per revolution promises greater output from a smaller, lighter engine.

Works Without Pistons

balanced. So working loads are opposed and cancel out. There is little vibration or concentrated stress to wear out bearings.

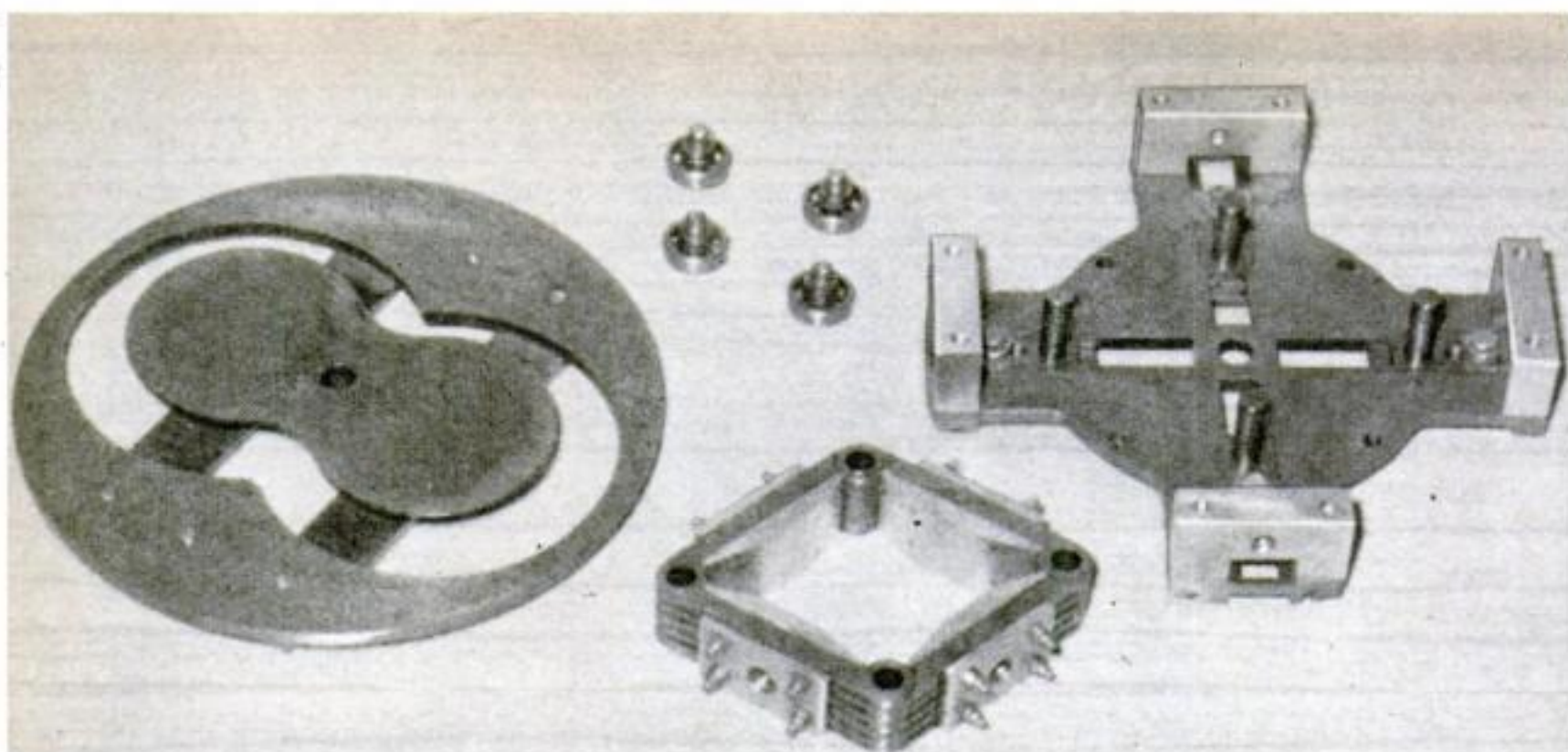
Rajakaruna has built one experimental model of four-cubic-inch displacement and 5:1 compression ratio. It runs merrily, but power output has not been measured as yet.

The pulsing engine is a box with hinges for sides. It can fold flat in either direction. Operation is magnificently simple. It opens to a square for intake. For compression, opposite hinge pins move toward each other while the other two pins move away from each other; the box is squashed and the fuel charge compressed.

Ignition sends the first pair of hinge pins away from each other, the second pair toward each other. At the end of the power stroke, the box has opened to a square again. But the pins keep moving, squashing the box the other way for exhaust.

The box is both cylinder and pistons, operating on a four-stroke cycle. It has valves controlled by cams on the drive shaft.

Sealing this pulsing box is much less of a problem than with other unusual engines such as Wankel's rotating piston. The top of the box is a stationary plate that is not fastened to the sides of the box—the moving sides wipe over the plate's surface. Besides closing in the



PULSING ACTION of box cylinder (center) is converted to reciprocating motion by its hinge pins, which end in slides fitting cross-shaped

slots (right). Roller bearings (top) are attached to slides and run in figure-8 slot of cam (left), turning it—and the shaft.

box cylinder, this plate also carries spark plug and valves.

The bottom of the box is a stack of slotted steel plates. None are fastened rigidly to the box sides, which must slide in relation to them. But the hinge pins in the corners of the box move in the slots in these bottom plates to convert the pulsing motion into rotation of the shaft.

One bottom plate is stationary. It has four straight slots forming an incomplete

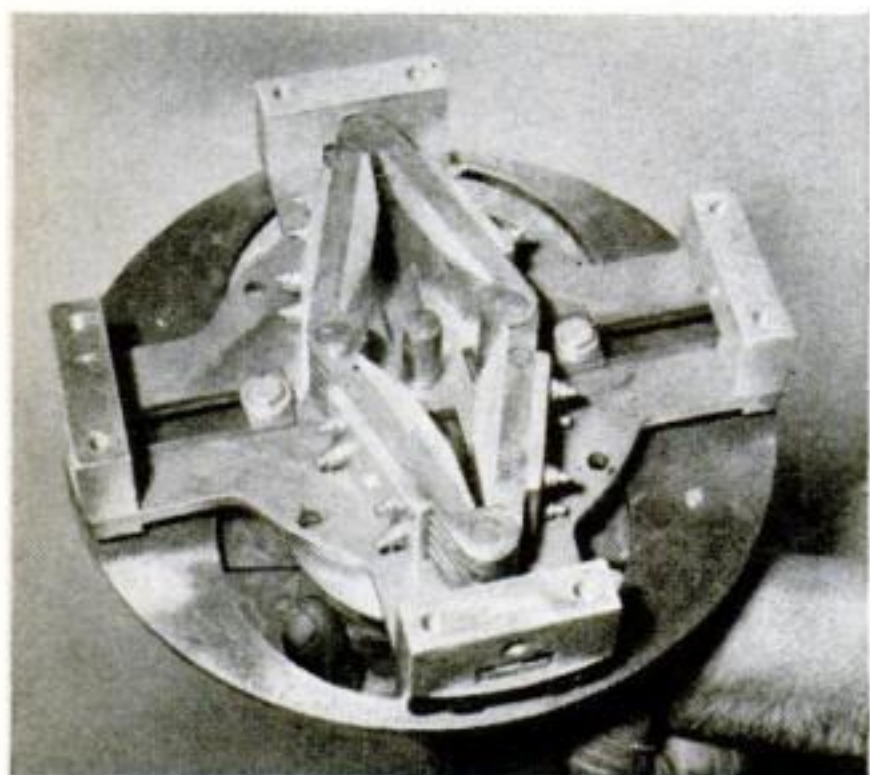
cross. The hinge pins are fastened to slides in these slots. The pulsing of the box moves the slides back and forth in straight-line reciprocation.

Under the stationary plate is the output cam, a circular plate with a wide-waisted figure-8 slot. In this slot ride roller bearings fastened to the reciprocating slides. The roller bearings push against the sides of the figure-8 slot to turn the output cam. The drive shaft is bolted to the center of this cam.

The next experimental model will displace six cubic inches, with output hopefully calculated for 15 hp. If those specs are met, the power-per-cubic-inch figure will be twice as good as that of the average piston engine. After that, there are plans to couple together several heart-beat boxes into a multicylinder engine suitable for cars.

Rajakaruna, a mild-mannered young man who has been tinkering with machines since his childhood in Ceylon, dreamed up the basic idea two years ago. He has been working on it steadily—usually at night—ever since.

He made the working model on the kitchen drainboard in his tiny apartment, using only hand tools. Materials were mild steel, aluminum, and odd plumbing fittings—the shaft-bearing housing is a pipe flange that he bored out with a broken twist drill stuck sideways through quarter-inch rod. ■ ■



HOW IT GOES TOGETHER: With valve-and-plug head removed, you see the cylinder just beyond top dead center for start of power stroke. The right and left hinge pins will move their slides outward in the straight slots. Rollers under the slides will turn the figure-8 cam.



TWO WAYS TO MAKE AN EYELET in rubber rope: Splice the rope into itself (left), as you would with Manila, or clamp it in two or more places with hog rings (right).

This Rope Stretches and S-t-r-e-t-c-h-e-s

NINETY-FIVE cents a foot is what you pay for this one-inch rope. Sound expensive? It would be—except that the rope stretches up to four times its original length. It's made of synthetic rubber.

Another interesting property: It's made in three strands in a right-hand lay. This means it can be spliced into Manila rope, as well as into itself.

Rubber rope is handy for tying down tents and awnings. It can be used, too, to snub shocks in a boat towline or anchor line. It's kind to hands and finished surfaces. It doesn't saw through decks and gunwales the way Manila does.

What's more, its ends don't unravel: The strands are held together with fine webbing. For splicing, the webbing severs easily with a knife.

The rope is made by the Griffith Rubber Mills, 2439 N. W. 22nd Ave., Portland, Ore., in sizes from $\frac{1}{4}$ to 1 inch. Prices start at 35 cents a foot.—V. Lee Oertle.



BAGGAGE STAYS PUT when lashed to scooters, jeeps, and car tops with rubber rope. Tied under tension, the rope won't loosen under vibration.



SHOCK SNUBBER for an anchor or mooring line can be made by forming a loop about a foot deep in the Manila rope and splicing a straight piece of rubber rope across the gap. Splice should be near the boat gunwale.



WANT A SPRINGY HAMMOCK? Fasten it to the support poles or trees with rubber rope. Use the one-inch size; it yields gently without breaking.

New batch of dream cars:

Clues to Cars to Come

These new experimental models look a lot closer to reality than earlier ones. At least, they offer strong hints to Detroit's future design trends

By Don Werner

EACH year a batch of dream cars is spawned in Detroit. Most are never shown to the public. When they are, they're worth looking over. They often hold clues to what's in store for tomorrow's production cars.

Five of these new engineering and styling prototypes are now on display. They're not too far out—each seems just a step away from production.

All have one thing in common: They're sporty-looking. Three are out-and-out sports cars. These are the Corvair Sebring Spyder, Tempest Monte Carlo, and Corvette Shark. The other two, the Dodge Flitewing coupe and Mercury Palomar station wagon, boast sporty interiors.

The most unconventional single fea-

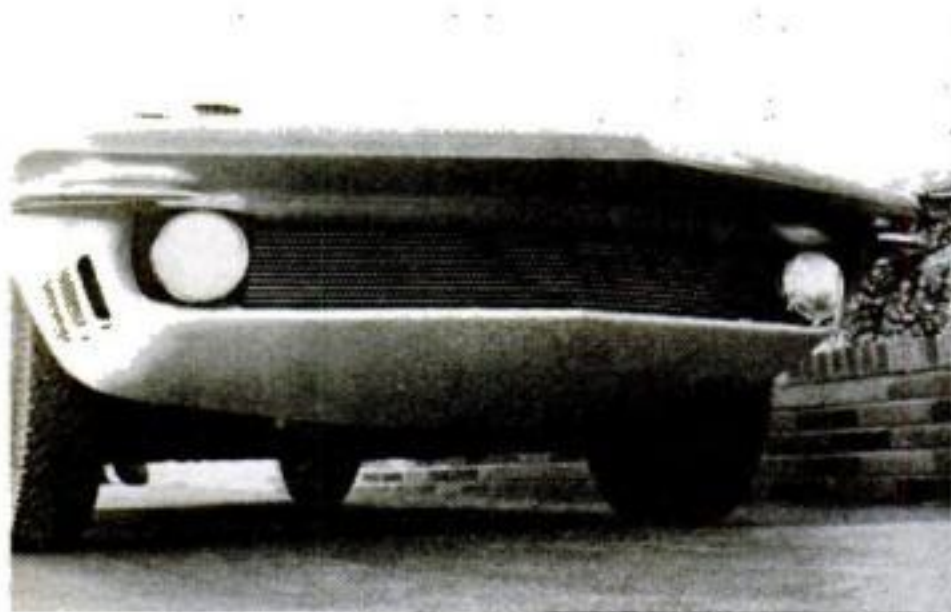
ture is in the Mercury Palomar wagon. The rear seat is elevated, and a section of roof above it opens for a roadster effect.

According to Dodge chief engineer George Gibson, some Flitewing features already are set for production. Of the many novelties, two stand out:

Each side window automatically swings up when its door is opened. Nondriving controls are off the dash. Some are on the driver's door panel, others in the console between front seats.

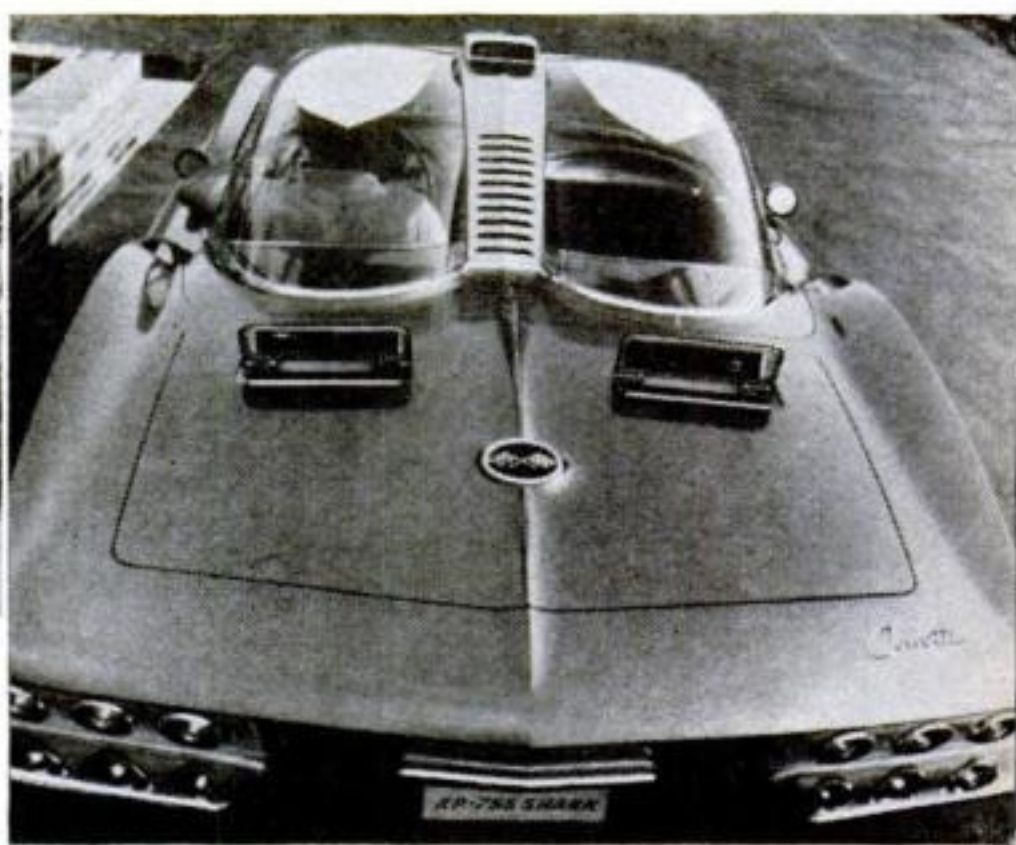
Of the three sports cars, the Corvair and Tempest stand the better chance of seeing production. Demand for small, inexpensive sports cars is steady, but Detroit lacks anything in this class. The Corvette is too costly for big volume.

The Corvair is only 162 inches long—not much longer than the MG-A road-

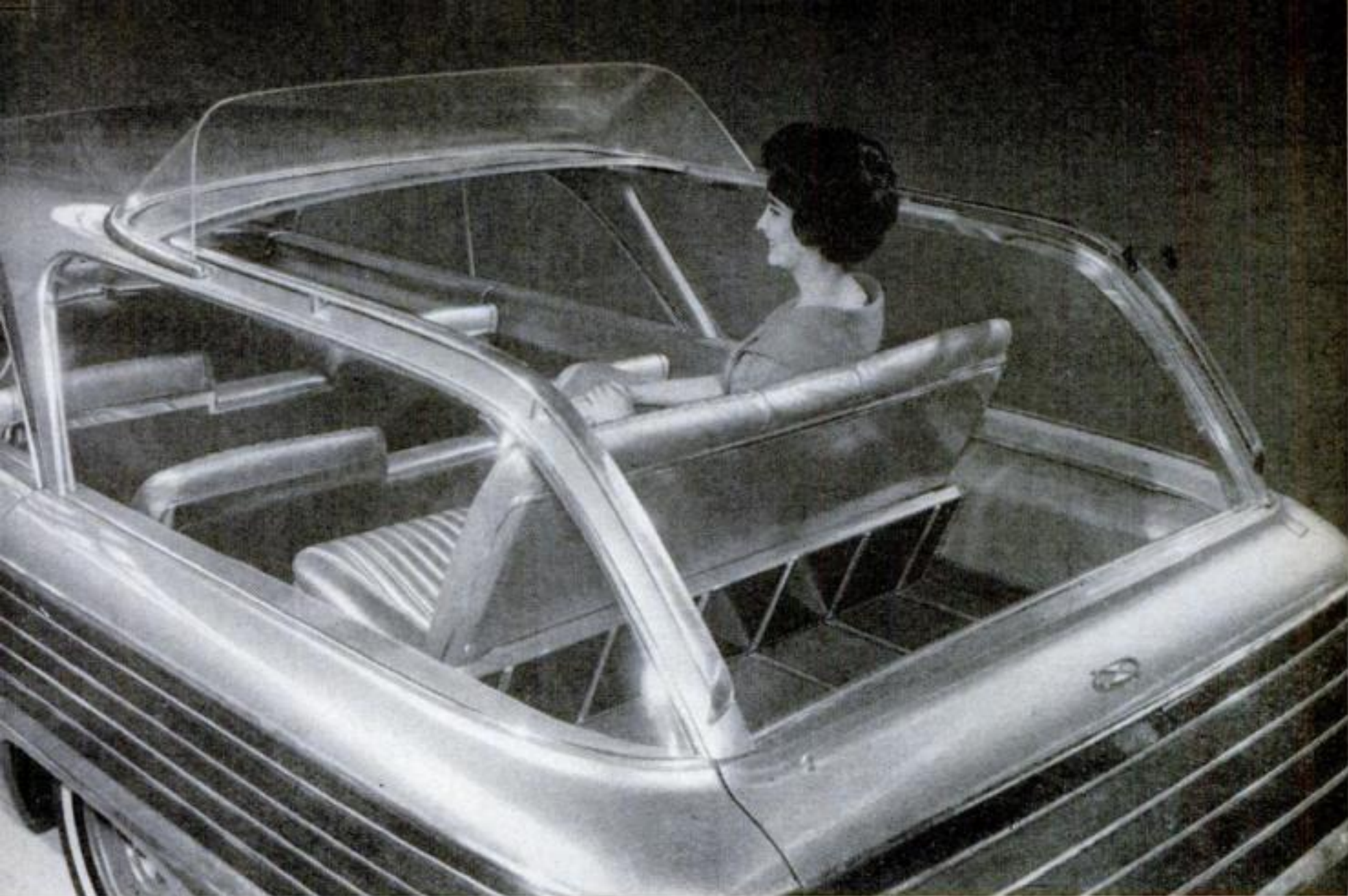


CORVETTE SHARK

Sharklike front end has single headlights (no quads for the '63 Corvette?) that retract when not in use to keep lenses clean. (This item isn't likely to see production.) Bumperless grille is vulnerable to Sunday drivers. Engine is regular 327-inch V-8 with four carbs and a supercharger.



Mirrored flaps high on deck lid reflect recessed directional and stop lights. Tail lights remain in standard position. Periscope replaces rear-view mirror.



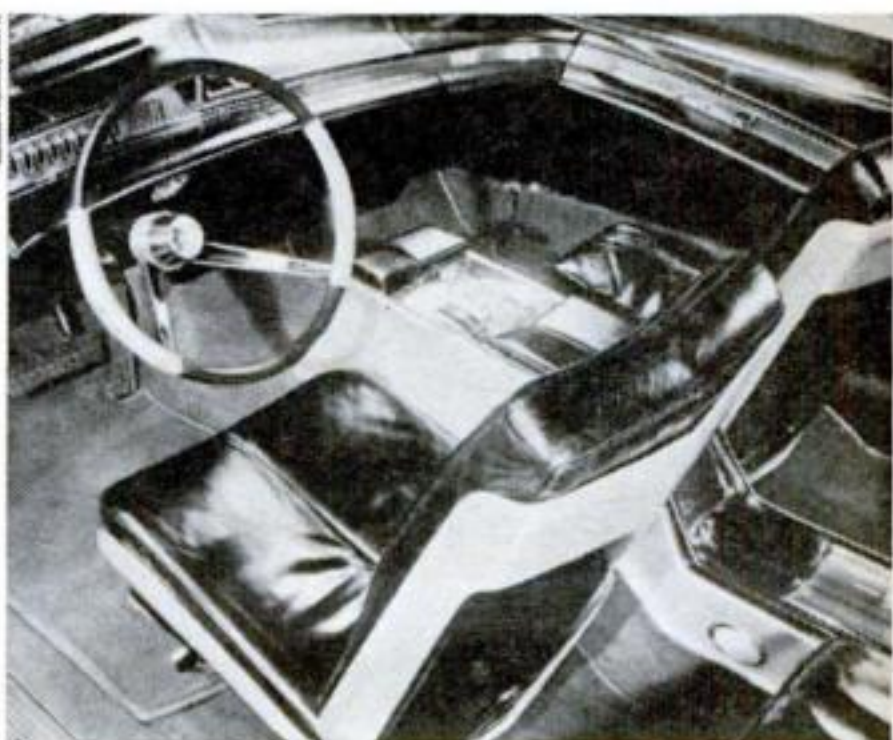
MERCURY PALOMAR

Low wraparound windshield is mounted at front of roof opening to prevent draft. Rear seat is raised so that passengers can actually look out over the roof. The wagon has no conventional gas or brake pedal—just two small disks, mounted flush with the floor, that are highly sensitive to the driver's foot pressure.



DODGE FLITEWING

Gullwing windows are powered by electric motors in the trunk. Rubber-tape switches along the bottoms of windows reverse the closing action when touched, preventing injury to fingers.



Thirteen oval lights on unusual speedometer represent graduations of 10 m.p.h. Radio, heater, and air-conditioner switches are in center console; other nondriving controls are on left door panel.



CORVAIR SEBRING SPYDER

Resembling a cut-down Corvair sedan, the roadster version is 18 inches shorter, has racing mirrors, dual windscreens. Blown Monza engine puts out about 130 hp.



True bucket seats give good lateral support. Seat belts (not visible) automatically roll up under floor when not in use. Welcome feature is full set of gauges in place of production car's idiot lights.

ster. The Tempest is 175. This makes them 18 and 14 inches shorter respectively than their parent sedans.

Despite Detroit's unhappy past experiences with supercharging, the Corvair has a Paxton and the Tempest and Corvette have GMC Roots-type blowers. These are not to be confused with the GM turbocharger described on page 77.

Among the Corvette Shark's features

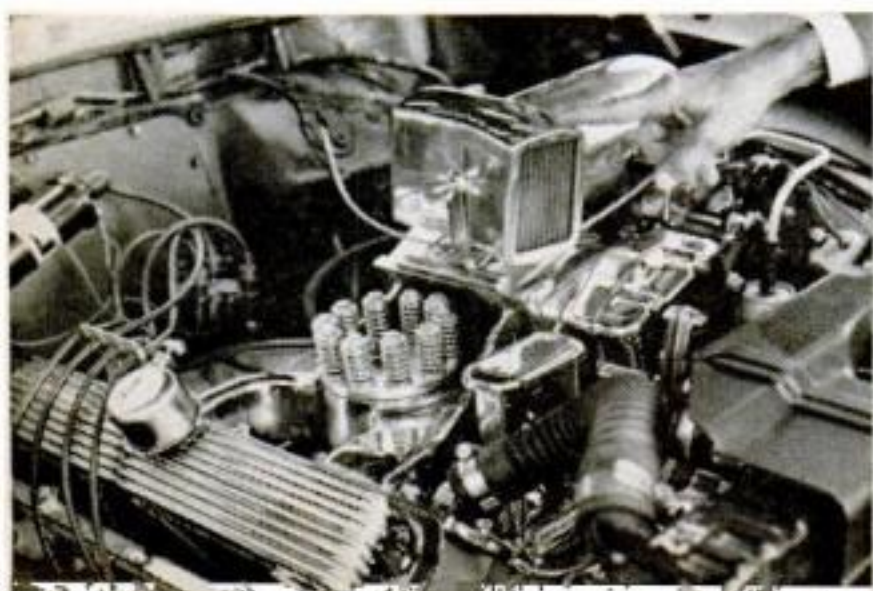
is a periscope through the roof. This solves a chronic Detroit problem—the rear-view mirror that obstructs forward vision.

One puzzling fact: The sportsters are all under 180 inches long, but the Mercury wagon is full-size and the Dodge coupe is 13 inches longer than the 202-inch production model. Could this pre-
sage a wider spread in car sizes? ■ ■



TEMPEST MONTE CARLO

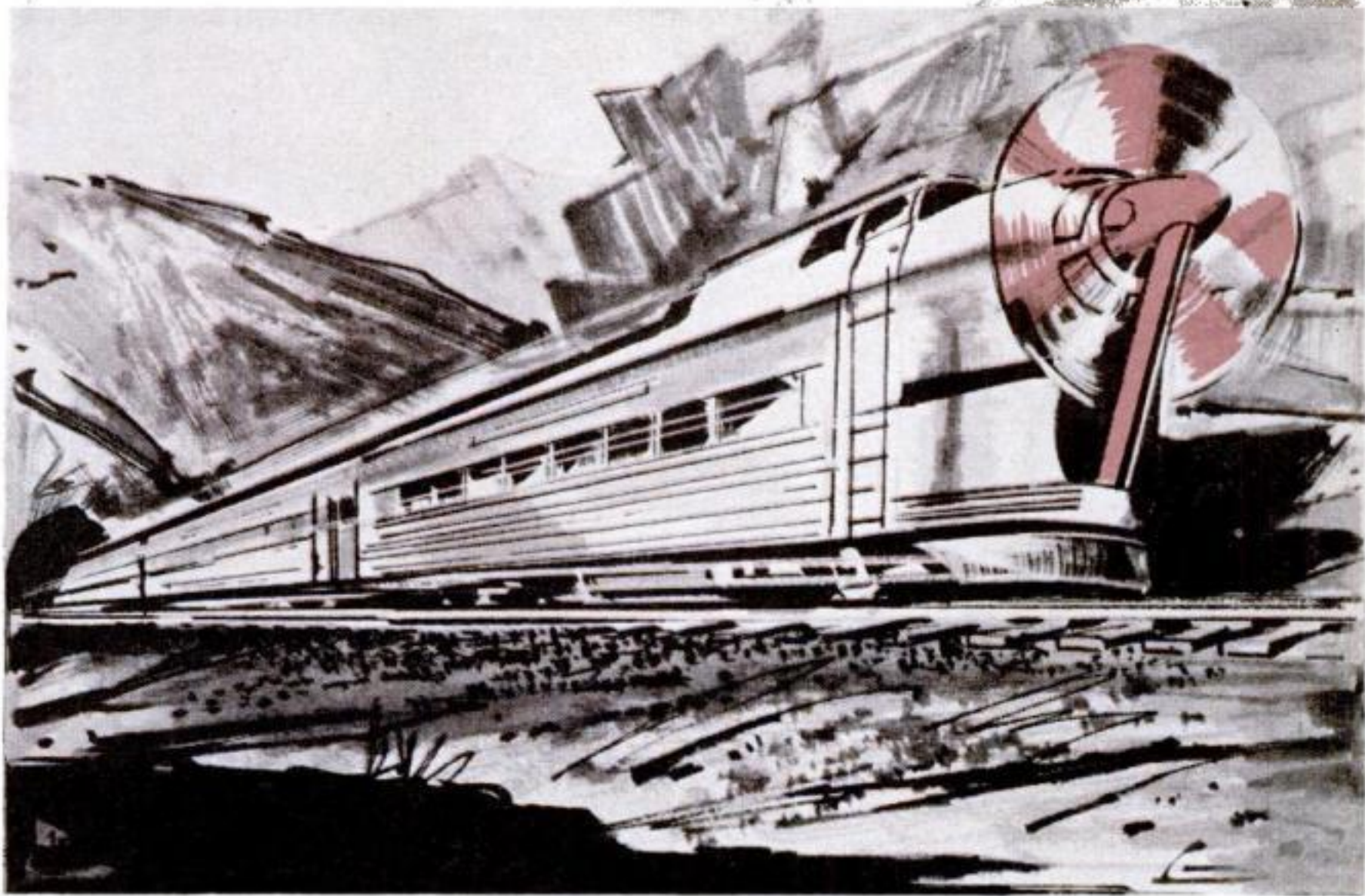
Twin headrests, wraparound racing-type windscreen, and louvered hood lend sporty air to this roadster. Cockpit, including bucket seats, is like Sebring Spyder's.



GMC blower whips up a storm in slanted four-cylinder engine. Chrome plating on valve covers, blower, and generator cover doesn't add hp., but it looks good.

New Ideas from the Inventors

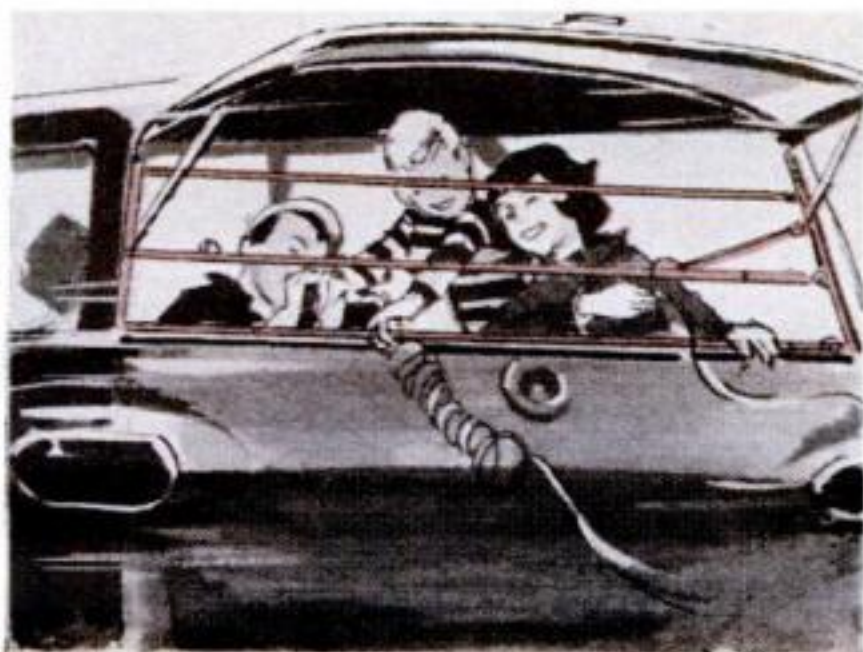
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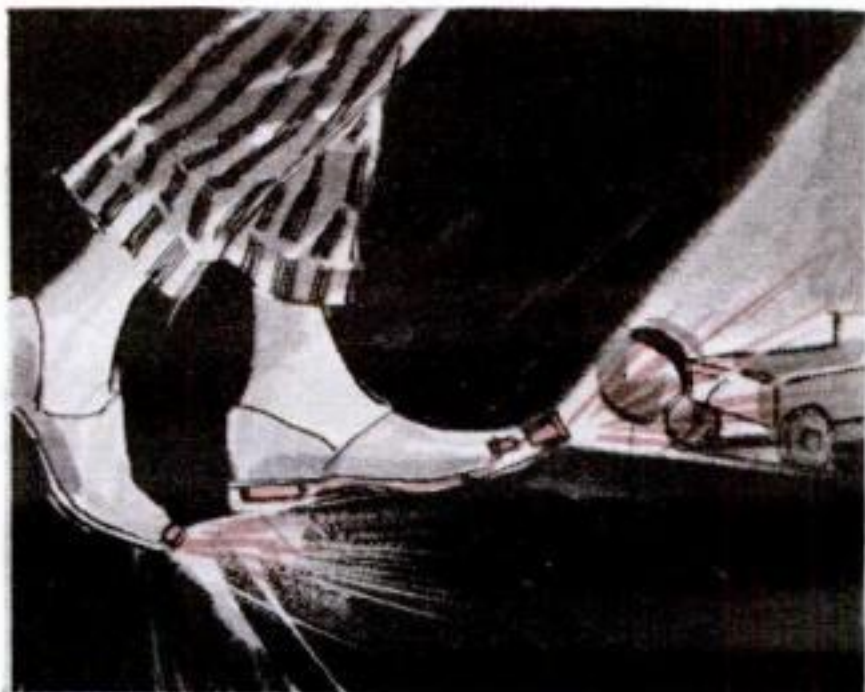
Props Pull and Push Train. With an airplane engine at each end, a short train—according to this recent Curtiss-Wright patent—could cruise at speeds up to 100

m.p.h. and beat plane service on many intercity trips. Pitch of the shortened propeller blades would be reversed for added braking effect.

Safety Bars Protect Kids. You wouldn't have to worry about letting children loose in the back of a station wagon if you could guard the open rear swing-door area with these telescoping rods. Adjusted to any wagon width, end channels would lock onto door edges so they couldn't fall—or be pushed—out.



Slipper Lights Your Way. You could walk through a darkened house without the risk of tripping over furniture or misplaced toys if your slippers had built-in headlights, like those shown below. Batteries would be pocketed in the heels, and you could turn the lights on or off simply by wiggling your big toes.



More Inventors' Ideas



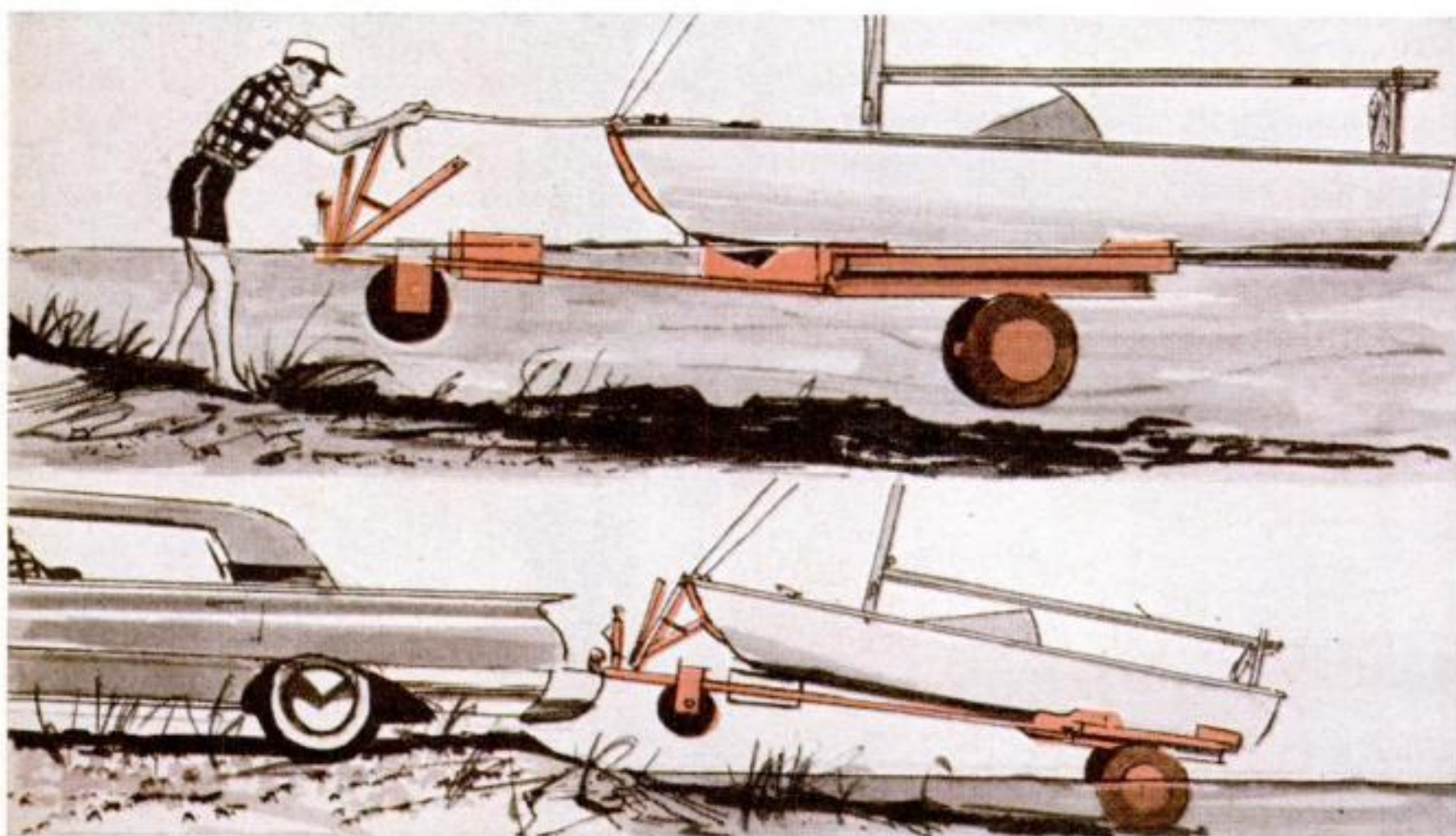
Rope Angles Tent Stake. Pulling a rope passing through two holes in this arrow-headed tent stake would turn the stake in the ground, so it would exert maximum holding power. A ball on the rope slips through the top hole, acts as a stop at the lower hole. An extra, harder, pull would point the stake up for removal.

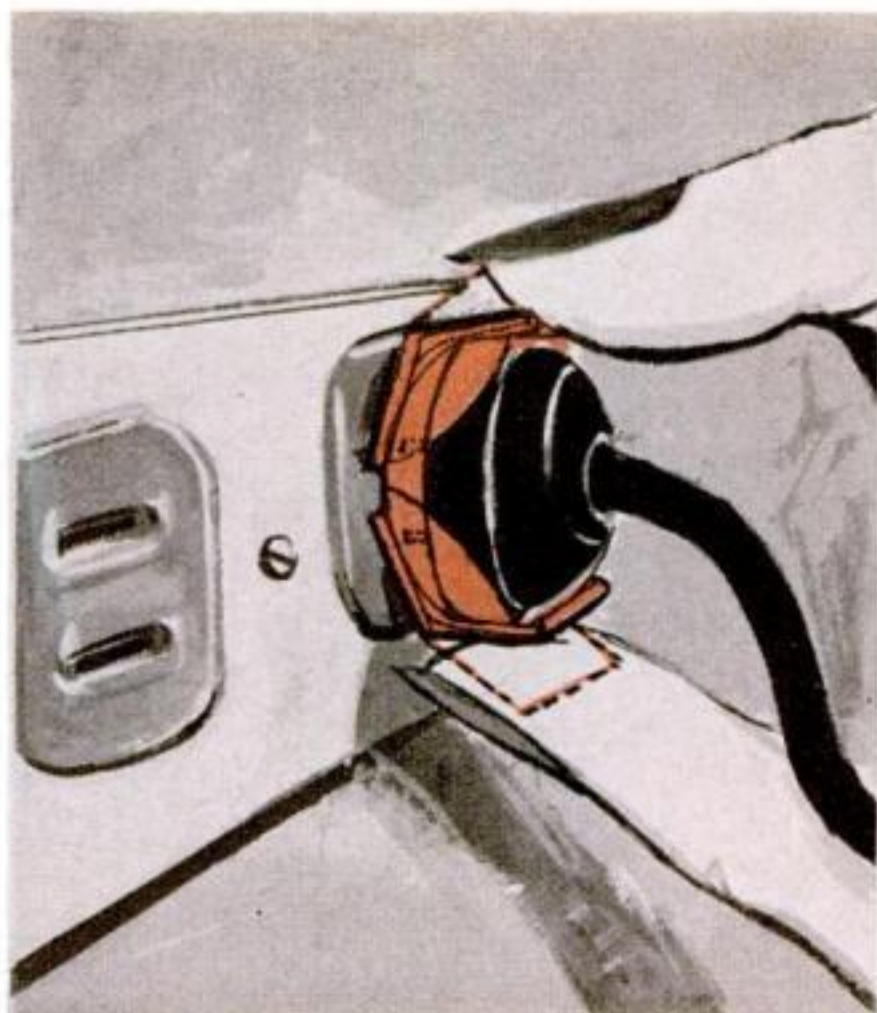


Register Counts Cash and Stamps. A supermarket checkout clerk couldn't forget or miscount your trading stamps if he had this dispenser attachment plugged into his cash register. As he rang up each customer's sale, the attachment would automatically compute and deliver the right number of stamps for the sale.

Trailer Floats to Your Boat. You could launch or beach a boat more easily with the help of this buoyant, hollow-beam trailer. After driving to a convenient

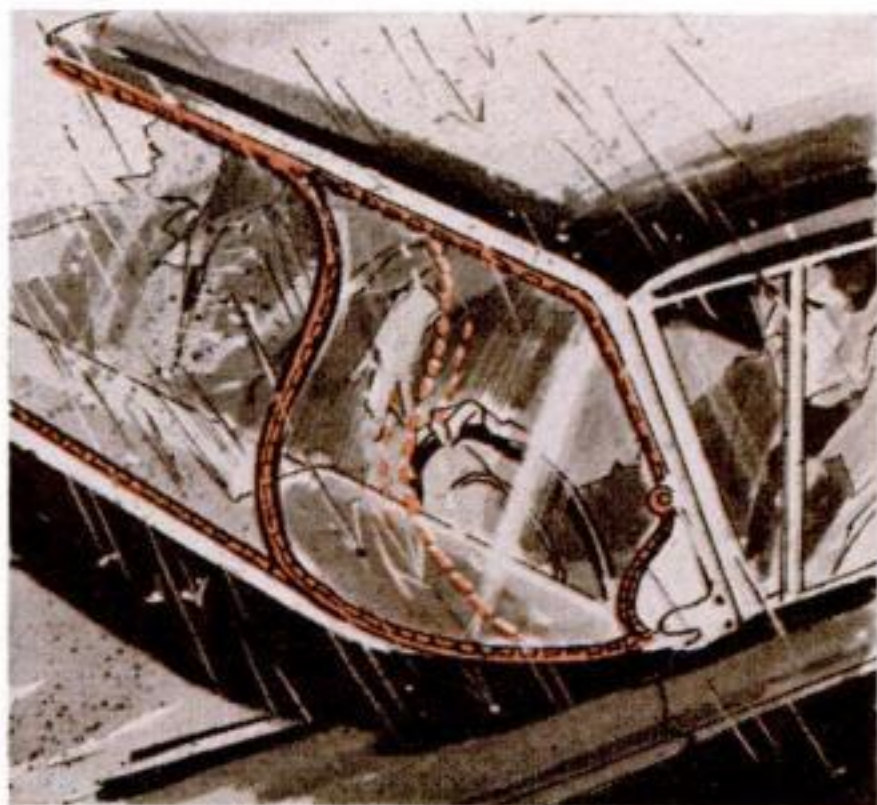
spot, you'd unhitch and dolly the boat out to floating depth. You'd then beach or anchor the trailer until you had to reverse the operation for the trip home.





Slide Pulls Plug Safely. You could disconnect any appliance easily and safely—and without tugging on the cord—if you used an ejector attachment like this on the plug. The thin plastic material of the slide would be slotted to clear the plug's prongs. Pinching the folded ears, as shown above, would force the plug free.

Magnetic Wiper Cleans Curves. By snaking from side to side across a windshield, this steel-cored squeegee might wipe some glass areas that ordinary wipers miss. A series of small electromagnets would be set into the windshield rim. A commutator would energize them in sequence to pull the wiper across.



Pole Lift Lifts Climber. A tree surgeon, lineman, or fruit picker could reach his work quickly, safely, and comfortably on this battery-powered lift. He'd use a telescoping rod to hook the cable to a tree or pole, then switch on a reel-up motor. Idler pulleys would level the seat, keep it clear of the cables.

The following patents have been issued on these inventions: Prop train—No. 3,007,421 to R. Hurley, Saddle River, W. Litke, Franklin Lakes, N.J.; Safety bars—No. 2,892,495 to W. Hadden, Kansas City, Kans.; Slipper—No. 3,008,038 to M. Dickens, S. Bilton, Holly Hill, S.C.; Stake—No. 2,892,518 to D. Fiske, Dover, Mass.; Stamp register—No. 3,006,538 to J. Deutsch, Zurich, Switz.; Trailer—No. 3,004,771 to J. Moore Jr., Lexington, Ky.; Plug slide—No. 3,008,115 to G. Oakes, Crystal City, Mo.; Wiper—No. 2,893,041 to G. Schafer, Santa Clara, Calif.; Lift—No. 2,969,125 to W. Hartford, Colton, Calif.

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington 25, D.C., at 25 cents each. To write to an inventor, if the address given above is insufficient, you may address him (by name and patent number) in care of the Commissioner of Patents.



Thrills for small fry: Six youngsters get underway at the starting line in a race of 6½-foot midget

Boys learn to become champs by racing

Wearing crash helmets and life jackets just like big-time racers, California youngsters compete on weekends in midget power boats. Races are conducted under regulations of the American Power Boat Association. They consist usually of four ¼-mile laps, with winners' trophies donated by local business firms. Parents

and others supervise the events, acting as officials and handling tune-ups.

All boats are built to racing specifications. The ones shown are Little Fellows, made by Fellows and Stewart, Wilmington, Calif. Constructed of plywood and fiber-glass, they are 6½ feet long and have a 35½-inch beam. The motor—a



ROUNDING A TURN calls for a high order of skill. Top speed of the boats is close to 20 m.p.h.



SAFETY REGULATIONS require young racers to wear crash helmets and life jackets.



runabouts at Marine Stadium, Long Beach, Calif.

midget boats

five-hp. Scott outboard, the limit for competition—is mounted inboard under an aft cowling, with the shaft running through the hull.

The boats weigh 130 pounds and are sturdy enough to take an adult in the single seat. The Little Fellows cost \$485, including motor.



FIVE-HP. OUTBOARD, mounted inboard, has shaft through hull. Remote controls are up front.



Fast man on two wheels

A French car-acrobat, Jean Sunny, set a new race-track record the hard way. On Copenhagen's Roskilde Ring track, he drove $1\frac{3}{4}$ miles in four minutes, nine seconds—on two wheels. He got his Simca into rollover position by driving its right wheels up and off a ramp, then kept it in balance by driving standing up with his head and shoulders out one window.



Lean-to for tune-ups

A new tubular stepladder puts the car mechanic on top of his job. Adjustable in height, it slides under the hood and enables him to reach every part of the engine compartment.

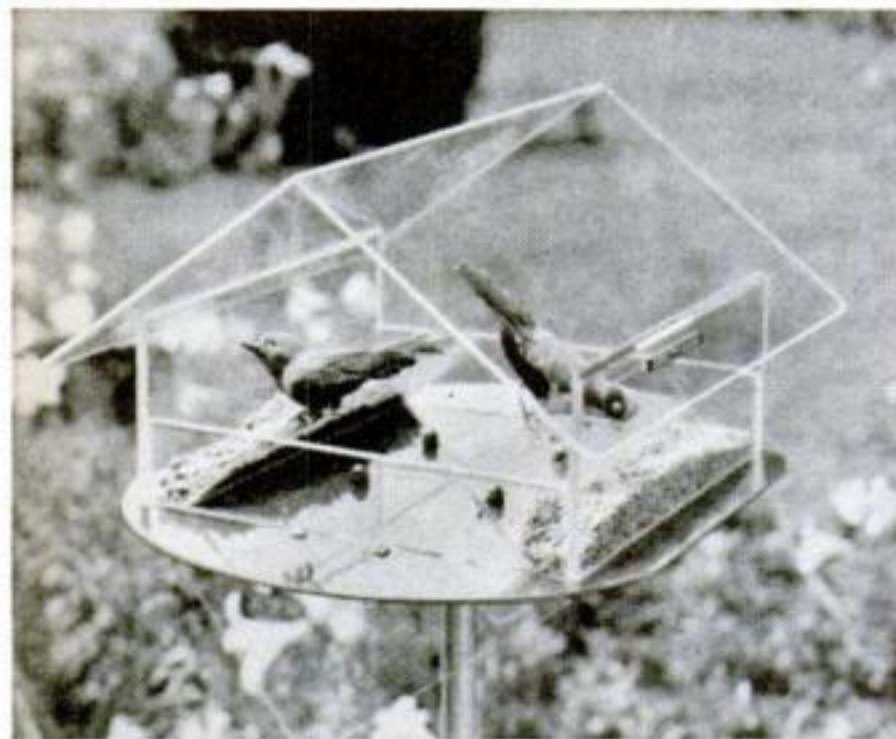
Hang-Over, a product of Hinckley Myers Co., Warren, Mich., is made of either steel or aluminum in sizes for work on passenger cars or trucks.



Three-wheeled scooter for work or play

With this little three-wheeler, you can pull a lawn mower or light trailer, carry a market basket or golf bag, add a second seat for a passenger. It's driven by a four-cycle, three-hp. Briggs and Stratton engine with a three-quart gas tank

good for 40 miles. A single pedal accelerates when you push with your toes, brakes when you push with your heel. Men-E-Uses Scooter is \$258; detachable seat, basket, and trailer are extra. Flinchbaugh Co., 390 Eberts Lane, York, Pa.



TRANSPARENT FEEDER of clear Plexiglas gives you a good view of wild birds as they eat. It's mounted on a ball-bearing ring, turns on a $\frac{3}{4}$ -inch aluminum pole. Fins on bottom keep one of the two closed sides always facing wind so birds won't be disturbed and feed won't blow away. Lazy-Susan Feed-O-Rama, \$20.95 without pole. Dilley Mfg. Co., 1657 Doan Ave., East Cleveland, Ohio.



DIAL-WINDING PHONE WATCH clips on center of dial, has a ratchet mechanism that winds Swiss movement every time you dial. Three phone calls daily keep it fully wound; safety clutch prevents overwinding. Stop-watch hand at top of face times long-distance calls up to 12 minutes. Date in calendar window changes automatically. \$14.95. Valu-Time Sales, 241 Lafayette St., NYC.

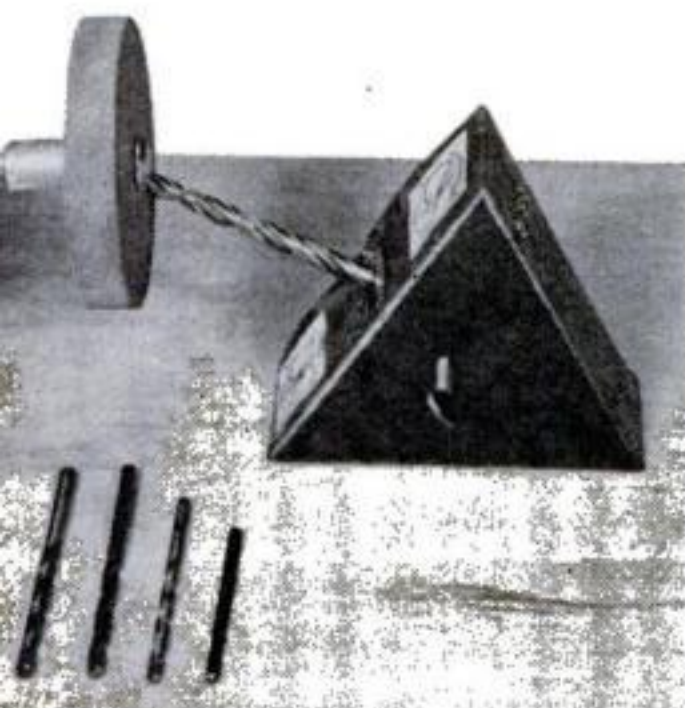
WHAT'S NEW



INCH-WIDE RUBBER BANDS are made in bright colors for use as straps to hold schoolbooks and as substitute for ribbon in gift wrapping. The elastic bands come in red, blue, white, green, gray, black, yellow, and orange. Package containing two bands sells for 19 cents. B. F. Goodrich Co., Akron, Ohio.



RADIAL-ARM SAW rated at two hp. is said to be most powerful nine-inch saw on market. Controls of Delta Super 990 are up front for easy reach. Motor has outboard-threaded shaft to permit mounting right-hand drill bits and routers. It's priced at \$249. Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh.



SHARPENING STAND is a triangular block that holds drill bits at 59-degree angle for precision sharpening against face of grinding wheel. Tapered mounting slot accommodates bits up to $\frac{3}{8}$ inch in diameter. Cost, \$1. Randolph-Page, Inc., 175 Fifth Ave., NYC.



BRICKLAYING TOOL has squeeze grip to hold brick in position for spreading on mortar and placing in wall. Thickness of jaw and lip is same as that recommended for mortar. Regular size, \$4.85; Roman, \$5.25. Port Austin Level & Tool Mfg. Co., Port Austin, Mich.



TAPE DISPENSER, complete with electrical tape, has feed slot. When you finish, pull down to cut with serrated edge and leave tab for starting next job. With 44-foot roll of $\frac{3}{4}$ -inch tape, \$1.29. Minnesota Mining & Mfg., 900 Bush Ave., St. Paul, Minn.

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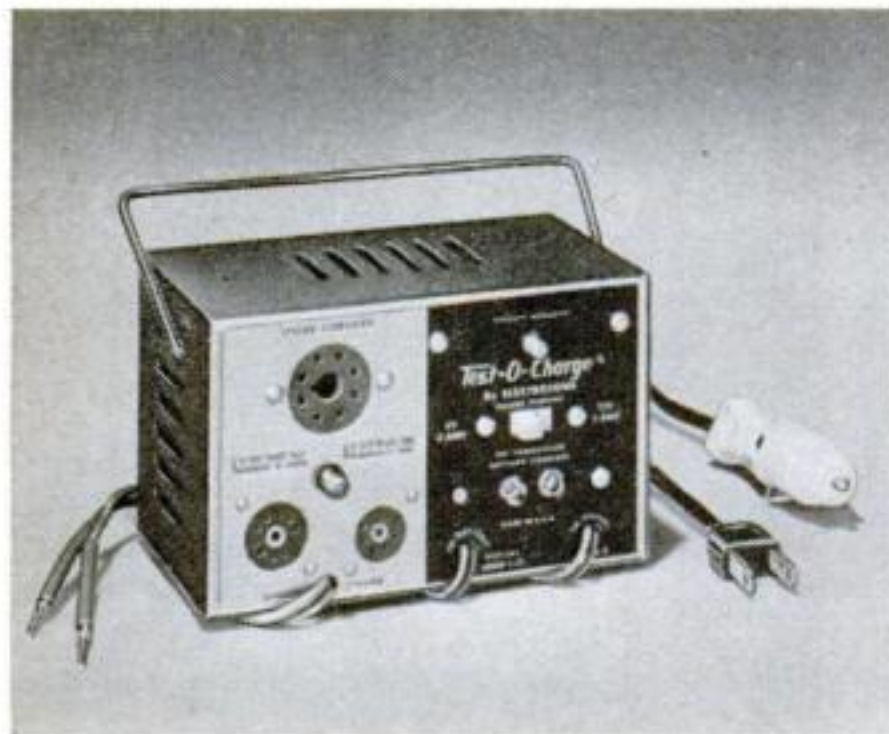
WHAT'S NEW



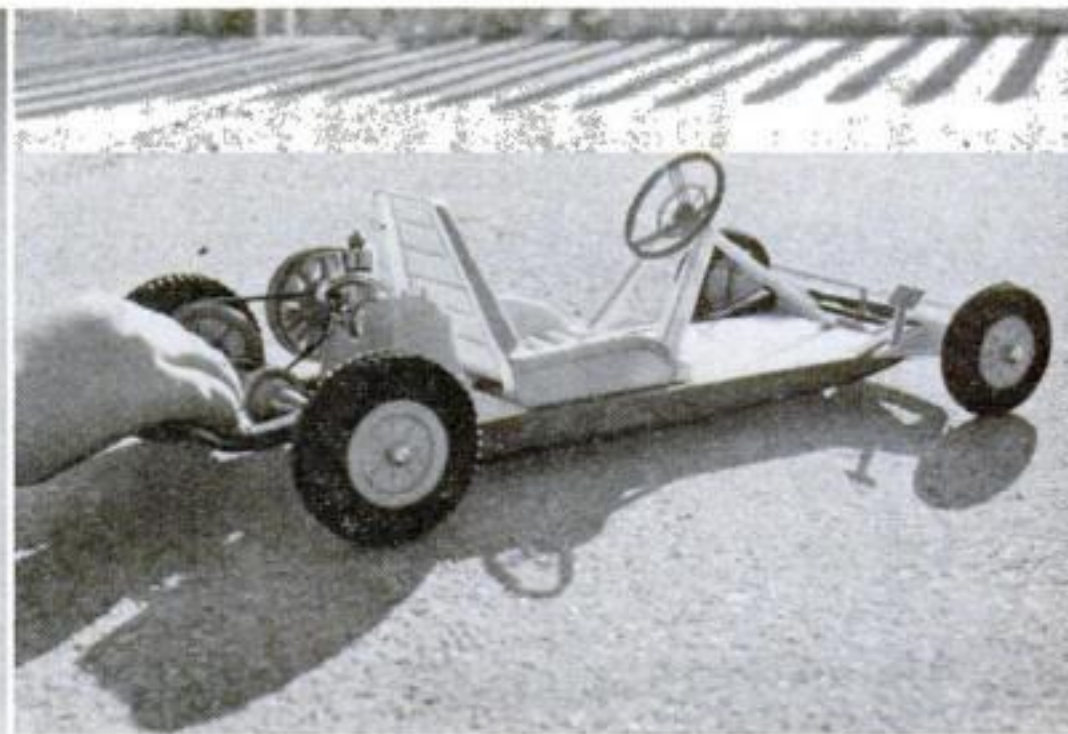
MINIATURE CAMERA AND FLASH cut your equipment load way down. Japanese Ricoh Caddy weighs 15 ounces and is 4½ inches long. It has built-in exposure meter, bright-line viewfinder, 25-mm. f/2.8 lens, shutter speeds to 1/250. It doubles number of exposures on 35-mm. roll by advancing film half frame. German Balda Luxi flash unit weighs 1¼ ounces, uses AG bulbs, has 9-inch cord that reels behind reflector. Camera, \$54.95. Allied Impex Corp., 300 Park Ave. S., NYC. Flash, \$4.95. Kling Photo Corp., 257 Park Ave. S., NYC.



MOWER ROLLERS fitted at front and back of rotary power mower won't let you scalp lawn if wheels run off curbing or into depression. They also aid edge trimming and act as bumpers. Pair, \$13. Protectorol, Inc., 13 Parkview Terrace, Rochester, N. Y.



TROUBLE SHOOTER is combination battery charger and continuity tester. Working through cigarette-lighter socket, it recharges a 6- or 12-volt car battery overnight. With it you can charge radio, boat, and farm batteries, or check tube filaments, transformers, and other electrical parts. Test-O-Charge is listed at \$16.95. Electrotone Laboratories, Inc., 1713 N. Ashland Ave., Chicago.



TOY GOCART is powered by the same kind of glow-plug engine that flies model planes. With neoprene belt driving wheels, the little engine will speed the 1⅓-foot racer up to 40 m.p.h. on straight-aways or on tethered runs with nylon cord tied to brackets under chassis. Complete with starter battery, fuel, and accessories, \$13.98. Wen-Mac Corp., 11511 Tennessee Ave., Los Angeles.



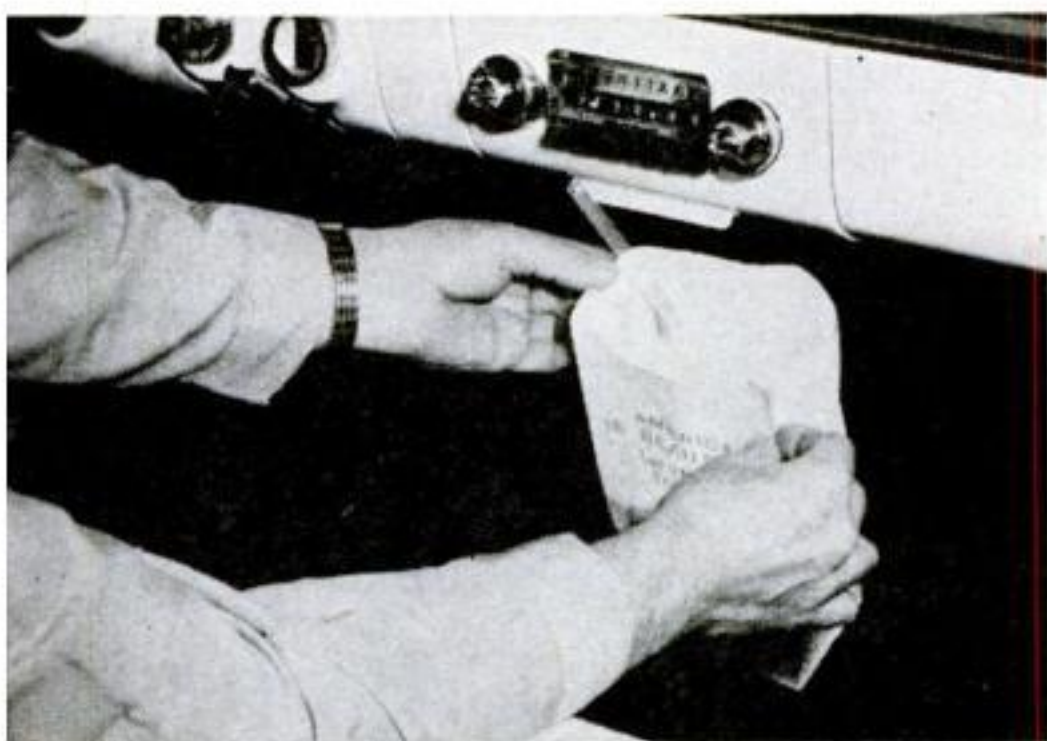
Laced plywood boat comes in do-it-yourself kit

You make this eight-foot sailboat by stitching sides and bottom. No frame is needed for fastening or support.

Plywood panels in kit are precut to shape, predrilled to take woven nylon cord, and prefinished on both sides with fiber-glass resin in colors. After lacing them together, you seal seams with thick

coating of the same resin inside and out, leaving fillet to hide lacing.

Graefin Scat sailboat is now available, and other models are planned. Kit includes hull, cord, resin, squeegee, mast, centerboard, rudder, sail, and all hardware. It sells for \$79 complete. Graef Marine, Box 125, Libertyville, Ill.



REFUSE-BAG HOLDER has plastic base with pressure-sensitive adhesive backing that sticks to car's dash. You push swivel arm through hole punched in ordinary paper bag, clip it back up on base. It holds sack firmly to make container for empty cigarette packs and other trash, so you won't throw them on highway. 50 cents. J H Enterprises, Inc., 3371 Water-side Dr., Akron, Ohio.



SEALING COMPOUND like that used to waterproof buildings now comes in kit for home jobs. Thiolaastic compound has polysulfide base and cures into permanently resilient rubber without shrinking. It seals expansion joints, gutters, flashings, cracks, windows, and boats. Kit contains sealant, calking-gun cartridge, and loader. \$3.25. Advance Polymer, Inc., 6475 Georgia Ave., Detroit.



"Gun" finds high-voltage leaks

The marksman above is hunting coronas with an ultrasonic "gun." Coronas, electrical leakage on high-voltage transmission lines, produce high-frequency sound waves. They are received by the Westinghouse gun and made audible through electronic circuitry.

A telescopic rifle sight on the instrument pinpoints the leaks so power engineers can correct them.



Dog gets a hitch on long hikes

When Tiny, a white miniature Pomeranian, tires on her walks, her master comes to the rescue. Robert Holsinger of San Bernardino, Calif., unzippers the flap on this carrying case and lets her hop in. The case is padded to make the ride soft.

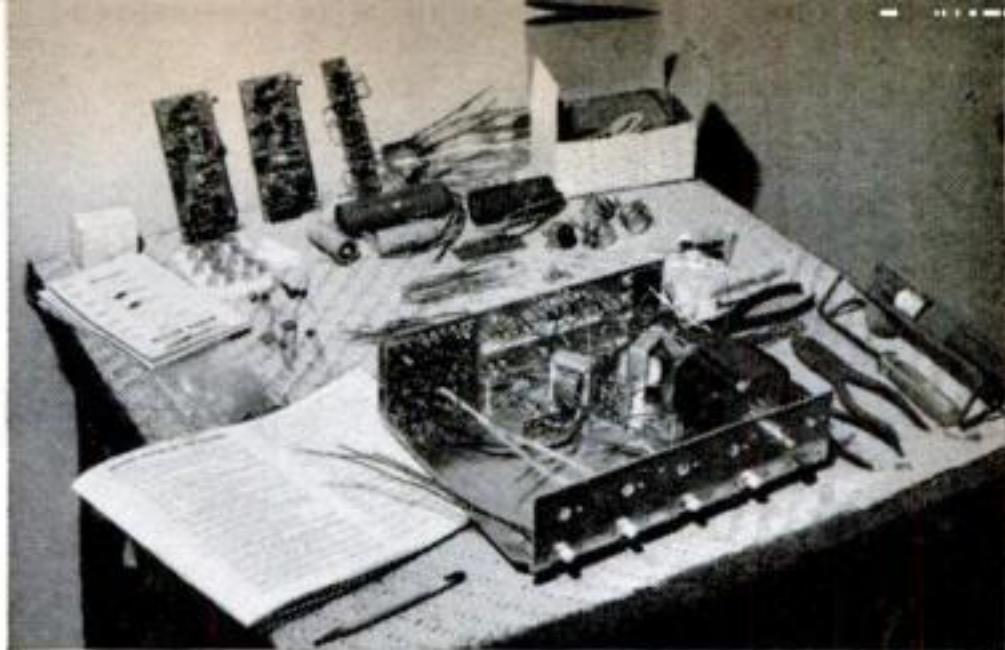


Trailer glides on air

Bumps on this test course in England may shake up occupants of the truck but not those in the Hoversled it tows. The

trailer rides on a cushion of air provided by two lift fans and contained by a flexible curtain. It's designed to evacuate military stretcher cases over rough ground without jolts or shocks.

**Transistors,
perfected in our
space program,
may soon bring**

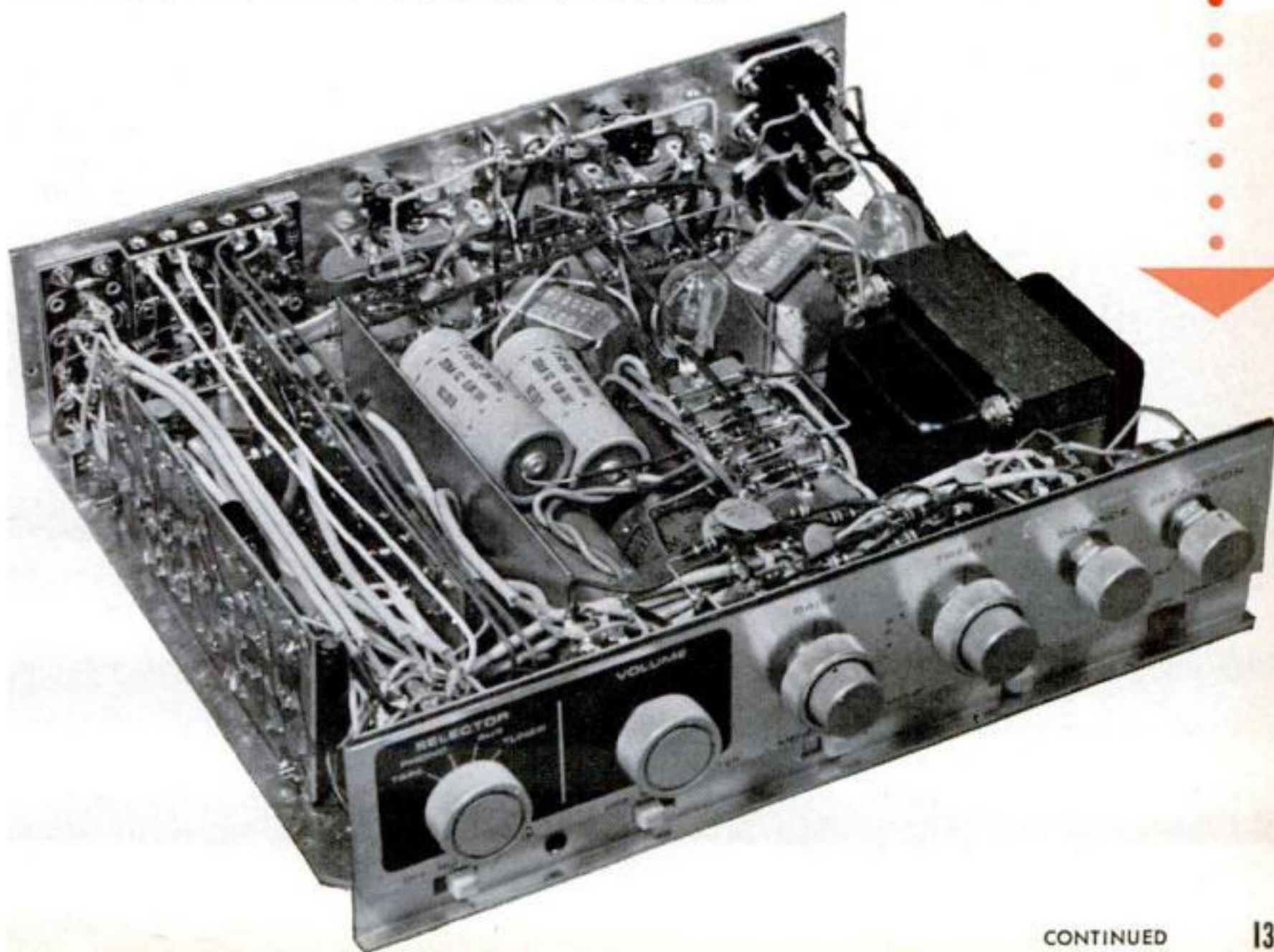


Hi-Fi Systems That Last a Lifetime

By Charles Tepfer

NEWs from the hi-fi design labs is that 1962 will be *the* year for transistor hi-fi. I've been talking to engineers for a number of equipment manufacturers, have been living with some of the new transistor components, and have built one of the new all-transistor stereo ampli-

ALL - TRANSISTOR, 50-watt stereo amplifier, built from a Knight-Kit, impressed author with clean, effortless sound. Terminal-board wiring and printed circuits minimize chances of wiring mistakes.



CONTINUED

Transistors promise amplifiers and tuners that are quieter,

| Transistor Hi-Fi Shopping Chart | | | | | |
|--|---------------------------------------|----------|--------------------|-----------------------------|-----------------------|
| Manufacturer | Component | Price | No. of Transistors | Frequency Response (c.p.s.) | Power Output (watts)* |
| ALLIED RADIO CORP. | Knight KN-310M stereo receiver | \$239.95 | 24 | 20-20,000 ±1 db | 40; 20 per channel |
| | Knight KN-450 stereo amplifier | \$199.95 | 18 | 20-30,000 ±0.5 db | 75; 37½ per channel |
| | Knight KN-250M multiplex FM tuner | \$139.95 | 8 | 20-20,000 ±1 db | |
| | Knight KN-400B stereo amplifier | \$ 99.50 | 16 | 20-20,000 ±1 db | 40; 20 per channel |
| | Knight-Kit KX-60 stereo amplifier kit | \$ 79.95 | 20 | 20-20,000 ±1 db | 50; 25 per channel |
| OMEGA | Stereo amplifier | \$249.00 | 31 | 18-20,000 ±0.3 db | 60; 30 per channel |
| TRANSIS-TRONICS | TEC FM-15 FM tuner | \$119.50 | 20 | 20-20,000 ±1 db | |
| | TEC S-15 stereo amplifier | \$129.50 | | 20-20,000 ±0.5 db | 40; 20 per channel |
| LAFAYETTE RADIO | LA-440 stereo amplifier | \$ 99.50 | 20 | 20-20,000 ±0.5 db | 40; 20 per channel |
| | LT-300 multiplex FM tuner | \$149.95 | 20 | 20-20,000 ±1 db | |
| RADIO SHACK | Realistic HK-208 stereo amplifier kit | \$139.95 | 18 | 10-15,000 ±1 db | 50; 25 per channel |

*"Music power" rated by standards set by Inst. of High-Fidelity Manufacturers

fier kits. The prospects are exciting for everyone who listens to music at home.

How would you like to have:

- Amplifiers and tuners that would last practically forever without servicing?
- Lower prices for equal quality?
- Smaller, less-conspicuous equipment?
- Less trouble with hum and noise?

The exacting demands and peculiar problems of high-fidelity reproduction have stubbornly resisted the revolution that transistors have brought in other fields. Now, help has come from an unlikely source—our efforts to put a man into space.

The spare-no-expense research effort to solve satellite communication and control problems has produced the necessary transistors and circuit know-how. The enormous demand created is bringing down prices through mass production.

Early attempts to use transistors in hi-fi gave them a black eye with many

designers. They were noisy, variable in performance, had limited power-handling capability, and introduced problems that tube men had never faced before. They went haywire when they got hot—noise and distortion soared, gain plummeted. Variations in individual transistors often required time-consuming adjustment of operating voltages on each unit. Circuit operation was sometimes upset by normal variations in line voltage. And most discouraging: With limited production, transistors were several times more expensive than tubes for the same job.

Why bother, then? This is the attitude many hi-fi equipment designers have taken. Tubes can do an excellent job for hi-fi in the home. There is no critical need for small size or low power consumption, the highly touted advantages of transistors. But now designers are taking a second look at the other virtues of transistors—virtues that can pay off in the long run:

smaller, and cost less to buy as well as to maintain

Long life is probably the one that speaks most seductively to you if you've lived with high-quality amplifiers and tuners. Tube equipment needs frequent attention to keep it performing at peak. Vacuum tubes start wearing out the moment you first turn on the switch. Long before the tube heaters actually burn out, tube performance may drop below acceptable hi-fi standards. Also, the intense heat given off by the tubes accelerates aging of other parts, leading to a long-term drop in sound quality—if not actual circuit failure.

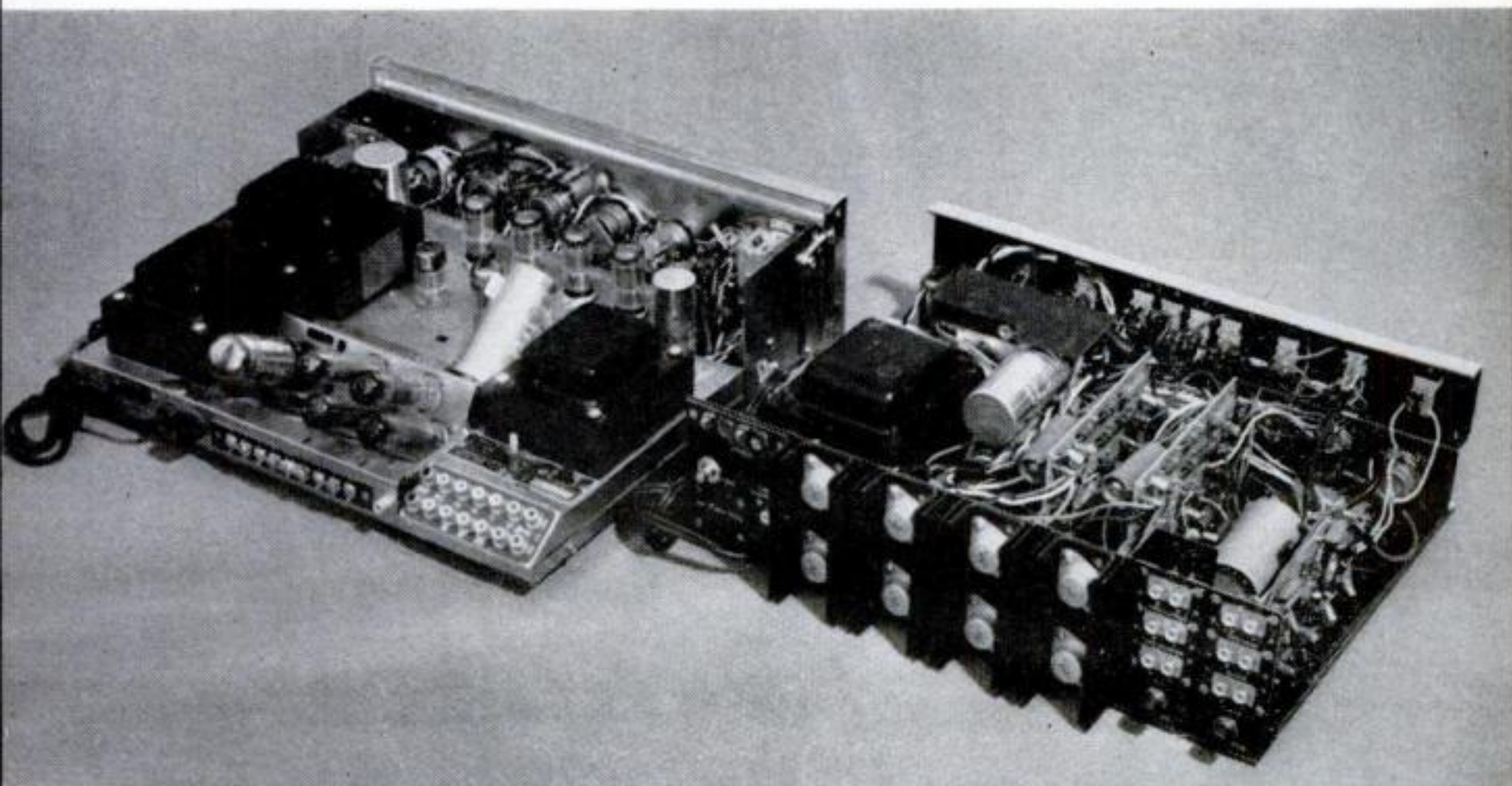
Transistors are not, automatically, a certified ticket to everlasting life for electronic equipment. But, engineers tell me, there is no theoretical reason why they shouldn't last forever if properly made and used. They have no filaments to burn up. There is nothing about them that gets used up. Transistor experts believe, although this hasn't been proved yet, that it is possible for a transistor amplifier or tuner to sound as good after 10 or 20 years of operation as the day it was first turned on. For top performance with tubes, you're likely to spend as much for repairs in four or five years as the set cost originally.

Lower prices cannot yet be counted among the attractions of transistor hi-fi. But, say experts, the day is not far off. Basically, transistors are cheaper to produce than vacuum tubes. But a lot of expensive tooling and research had to be paid for. That's one reason transistor prices have been high. Another is the fairly high percentage of rejects, transistors that don't come up to specs after manufacture. Both of these conditions are rapidly improving.

A big saving with transistors comes from eliminating the output transformer. In tube amplifiers the output transformer, more than any other single part, determines the quality of the amplifier. And a good one is expensive. Transistors can drive a loudspeaker directly.

Part of these savings are eaten up by the greater number of transistors and huskier capacitors needed. But some hi-fi manufacturers predict that by 1963 there will be no price difference between tube and transistor amplifiers of comparable quality—and from then on, costs will favor transistors.

Less-conspicuous equipment may not seem a particularly strong selling point if you think merely in terms of smaller



TRANSISTOR STEREO AMPLIFIER at right here has nearly twice the power output of the tube amplifier beside it but weighs only half as

much. In a side-by-side test, tube amplifier heated to 215 degrees after 30 minutes of operation—transistor amplifier to only 75 degrees.

versions of separate amplifiers and tuners. This is what is presently available. But more imaginative engineers see the not-too-far-off possibility of almost invisible electronic gear. With transistors, it is entirely feasible to tuck power amplifiers inside the magnet housing on loudspeakers. Pre-amps and tuners could be interlaced in turntable, record changer, or tape-recorder machinery. The present clutter of equipment and interconnecting cables could be reduced to two units with only a pair of wires connecting them.

Hum and noise top the list of hi-fi pet peeves. Listeners who will let a fairly high level of distortion pass unnoticed, or ignore a slight loss of extreme treble or bass, will make a repairman's life unbearable if he can't rid their rig of a barely audible hum. Much of the hum and noise in tube equipment stems directly or indirectly from the 60-cycle AC used to heat the tube filaments. Eliminate the filaments and you banish a major part of these troubles.

And, of course, transistors are much more rugged, mechanically, than tubes. They are not subject to microphonic noises—those resulting from physical vibration of the working parts inside a tube.

Some of the big transistor manufacturers, such as Texas Instruments, are pushing the transistor hi-fi revolution by offering tested and proven circuit designs to equipment manufacturers. The conservative majority of hi-fi manufacturers are wary, but few dare to ignore the possibility that tube equipment may be obsolete in a few years. Some engineers—even though their companies are publicly down-playing transistors at the moment—have told me privately of their enthusiasm for transistor projects in the company labs.

Transis-Tronics, Inc., has been a pioneer in the field. They make only tran-

sistor hi-fi. It has been available under the TEC label and is now also sold under several private labels. They have recently produced a remarkable 20-transistor, 9-diode FM tuner with a stereo-multiplex version using 8 additional transistors.

Allied Radio, a leader in getting to the public with transistor hi-fi, offers the broadest line. They have just come out with five new pieces of transistor equipment under the Knight and Knight-Kit label. Dick Medal, their consulting engineer, makes four points he considers essential for success with transistors:

1. Design complete all-transistor systems. Don't try to mix transistors with conventional tubes.
2. Build in multiple safeguards to protect the transistors from voltage peaks.
3. Use only the new, low-noise, stable, mass-produced transistors that stick to the design specifications.
4. Design conservatively, allowing plenty of latitude for minor variations in individual transistor performance.

I built the 50-watt, all-transistor Knight-Kit stereo amplifier.

I quickly discovered that the use of transistors doesn't necessarily result in faster and easier kit construction. You pay dearly for chassis compactness in tight wiring. But transistors are natural partners of printed wiring, and the use of circuit boards in this kit greatly reduces the chances of error. Future kits could probably make even greater use of printed wiring and speed the job of assembly considerably.

After my disappointment with some of the earlier transistor equipment, I was pleased to find the sound of this amplifier clean and effortless. I certainly can't fault it on performance. And I've grown fond of one of the minor advantages of transistors: The sound comes on instantly when you flick the switch—no waiting for tubes to warm up. ■ ■

What Is a Transistor?

Transistors were invented in 1948 at the Bell Labs by William Shockley, John Bardeen, and Walter H. Brattain, who were later awarded the Nobel Prize in physics for their work.

The word transistor is derived from TRANSfer resISTOR (i.e., there is a considerable difference in the input and output resistance).

Both transistors and vacuum tubes are designed to amplify a signal. But here's the big difference: The current carriers in a vacuum tube (electrons) are boiled off a hot cathode and travel across an evacuated space to the plate. Considerable electric power is needed to heat the cathode. In a transistor, the current carriers exist in a semiconductor crystal and move through a solid from emitter to collector.

Exploring the 'Moon' by Jeep

Dead volcanoes in the California desert may give space scientists clues to how explorers could live on the moon

By Wesley S. Griswold

ONE morning late last winter, as a bright dawn was spreading across the California sky, I set out for a day's trip to the "moon."

This was no mere fantasy. I was bound for a region that a scientist friend of mine believes is very much like parts of the moon. It lies in a volcanic area of the Mojave Desert, about 170 miles northeast of Los Angeles.

My friend, Jack Green, was at the

Tough boots are shredded in climbing up jagged volcanic rocks like these that might be found on the moon.





A preview of the landscape on the moon? That is what North American Aviation

wheel of the jeep. An enthusiastic young research geologist with a Ph.D. from Columbia, he's on the staff of North American Aviation's Space Sciences Laboratory, in Downey, Calif. At 35, he has already devoted 10 years to specialized study of the moon.

As the jeep churned up through Cajon Pass and over the southern rim of the high desert, I asked Dr. Green about his work.

"I believe that more than 95 percent of everything we see on the moon is of volcanic origin," he said. "So I spend as much time as I can in volcanic regions, trying to anticipate what our astronauts will find on the moon when they get there. The goal is to determine how they can best use what they find.

"You ought to know, though," he added, "that not all students of the moon believe as I do. There are geologists and astronomers who agree with me. But there are many others who don't."

"What do the others think?" I asked.

"They think the moon's surface was formed by the impact of meteors."

"What difference does it make?"

"Lots of difference," Green answered. "If *they're* right, then the moon is littered with chunks of iron and stone meteorites. There's probably nothing there—except iron—to help man survive. He'll have to do his lunar exploring the hard way, taking nearly everything he needs along with him."

"On the other hand," I said, "if *you're* right, and the moon is volcanic, what then?"

"Wait a little while," Green replied. "Then you can pretend you're a lunar Robinson Crusoe. I'll show you where you might find water, warmth, protection, building materials, and vital minerals up there."

Gear for a moon trip. We were dressed for the field trip in dungarees and heavy Army boots. In the back of the jeep were a couple of hard hats, a geologist's hammer, a scintillometer (for detecting radioactivity), two flashlights, box lunches, a small iron crucible, and a strange gadget that I had never seen before.

"What's that thing?" I had asked, pointing to it, when I got into the car.

"That's a Fresnel lens, the heating unit of a solar furnace," said Green. "It's plastic—concentrically micro-grooved. Works like a magnifying glass. Yet it's light, and can be rolled up like a scroll. It's unbreakable. On the moon, micrometeorites might zing right through it, but they wouldn't shatter it."

It looked like a lens, all right, though not as clear as glass. It was mounted at the top of a footed metal support.

"What'll we do with a solar furnace?"

"If we were on the moon, it'd be just about the most important piece of equipment we could have with us," Green replied. "We'd use it to distill water out



scientists believe they are viewing on their expeditions to the volcanic Mojave.

of rocks, and melt minerals. I brought it along today to melt sulfur."

"Why sulfur?"

"That's the most abundant mineral in volcanic regions. A lunar explorer would find it extremely useful."

At 9:30, Green turned the jeep off the highway, 40 miles east of Barstow. He guided it over coarse sand and sagebrush toward an unmistakable volcanic cone that rose blackly out of the desert.

"That's Pisgah Crater," Green said. "It's about half a mile wide at the base, and around 700 feet high. It's a cinder quarry now. I want to show you the vent of the volcanic cone. That's where astronauts would be wise to explore if this were the moon."

He stopped the jeep near the base of the crater and told me to put on my hard hat. Then he gathered up the flashlights and scintillometer, and led

Lab version of Dr. Green's solar furnace for extracting water from rocks consists of Fresnel lens (left in photo), vacuum container for crushed rock, and (right) improvised cold trap. Vacuum container rests on photographic jack, for easy positioning. Valve outlet at left is where vacuum pump is attached. Water distilled from crushed rock goes through glass tube into cold trap containing dry ice, and condenses.



the way up a steep, rough, winding trail to the summit.

Inside the crater. We half slid, half stumbled over the rim and down to a fairly level area inside the cone. There we approached what looked like the mouth of a crudely made well. It was pitch dark inside. This was the vent of the long-dead cinder cone.

Green handed me a flashlight.

"You'll need this," he said. "The vent goes in around 50 feet."

"I'm not going in any 50 feet," I protested.

"Okay," said Green, with a laugh, "but come take a look, anyhow."

Following him, I apprehensively crawled a few paces out of the sunlight. The cone's cold vent was black, jagged, and forbidding. The beams of our flashlights reflected dully from its narrow walls.

"Here's the sort of place where a moon explorer could expect to find minerals he could use, such as sulfur and sal ammoniac—maybe gypsum," Green said. "He could distill water from gypsum. Sal ammoniac could be used as a source of ammonia and chlorine, both very valuable chemicals for possible lunar technologies. And sulfur—well, it has a score of important uses.

"There might even be ice in a sheltered spot like this on the moon," he added thoughtfully. "Part of the water vapors created in lunar eruptions may have formed ice, and in the intensely cold shadows and high vacuum of the moon it may have persisted over geologic ages."

Green began to move his scintillometer about him with the gestures of a man sprinkling a flower bed.

"A man on the moon would also be looking for radioactivity here," he said.

"Why should he?" I asked.

"He'd hope to locate radon and argon," Green explained. "They're slightly radioactive gases. Radon is formed by the decay of uranium, argon by the decay of potassium. Where those gases exist, usually within deep volcanic fissures, the lunar explorer could conceivably have the beginnings of an atmosphere. He could then enrich it with other gases, derived from pumice or scoria, until it was breathable."

"Let's climb into a little richer at-

mosphere ourselves," I suggested. "And what's this about scoria?"

We emerged into the hot sunlight, and sat down. Green gestured toward the rocks that formed the volcano's mouth. They looked like huge black sponges.

A man-made atmosphere? "That's scoria—basaltic froth," he said. "On the moon, unless the gases have diffused from its pores, scoria should contain carbon dioxide, nitrogen, and hydrogen. Those are necessary ingredients for a breathable atmosphere. And moon explorers will certainly *want* to create such an atmosphere in some nook or cranny.

"We're already crushing cubes of pumice under a high vacuum in the lab," Green continued, "to find out whether appreciable amounts of these gases can be recovered that way. Scoria or pumice might also be used for lunar construction, and for insulation, too."

Before long, we were back in the jeep, crossing a jumble of cinders and lava that nearly shook our teeth loose.

Green waved a hand at the vast upheaval of basaltic lava all about us. "You probably think that's nothing but a nuisance. To a man on the moon, certain types of basalt may represent a bonanza. For example, he could make surprisingly strong bricks out of basaltic ash and sulfur.

"The Czechs have already remelted natural basalt and cast it into pipes, bars, tiles, and many other structural components. Moon basalt could be the raw material for many products."

He lifted the Fresnel lens out of the back of the car and carried it to a relatively smooth spread of lava about a quarter of a mile away. He moved the lens until the little circle of intense light it collected was focused on a shallow crack in the upper surface of a lava tube—a kind of natural culvert.

"I'm going to patch that crack with molten sulfur, which makes a fine waterless cement. I'll have to heat the fracture first, though, so the sulfur won't 'freeze' when I pour it."

In the meantime, he said, he'd show me where a man on the moon might

[Continued on page 228]

.....
Another lunar preview? This is Craters of the Moon National Monument, in Idaho. Photo (right) shows "Big Crater."



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A black and white photograph of a man in a workshop. He is wearing a light-colored, short-sleeved button-down shirt and dark trousers. He is leaning over a compact drill press, which is a small, portable machine mounted on a stand. He is using the drill press to drill a hole into a piece of wood. The machine is compact and designed for portability. The background is a plain, light-colored wall.

Mechanics and Handicraft SECTION

SHOP-TEST REPORT:

The New Compact Tools

By Harry Walton

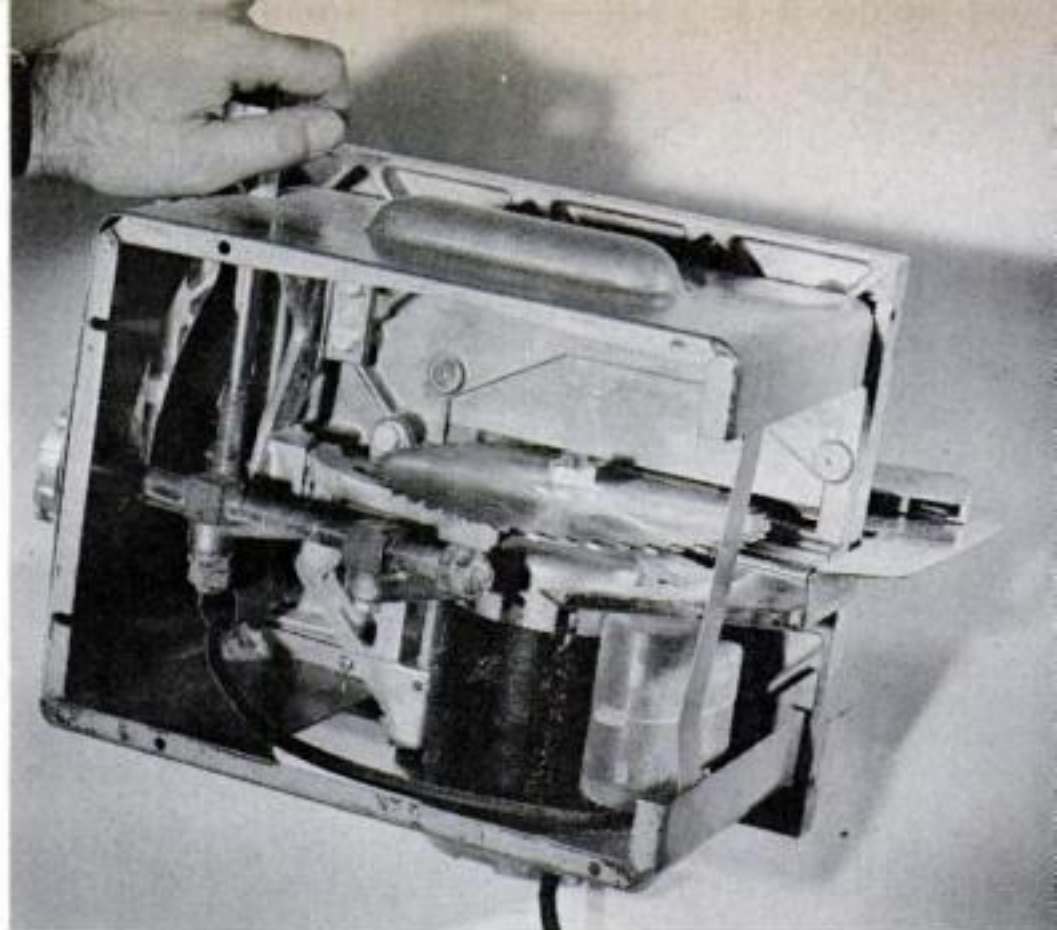
WHEN a toolmaker says he can give you a shop machine half the size of a standard one, make it portable, and still get it to do the same top-quality work, that's a mouthful. One toolmaker—Rockwell Mfg. Co.—has done just that. Already famous for

its Delta line of tools, the company is backing up its claims with three new ones: a full-fledged drill press only 25" tall, a 4" jointer light enough to tuck under your arm, and a compact table saw that, despite its small size, swings a hefty 7 $\frac{1}{4}$ " blade.

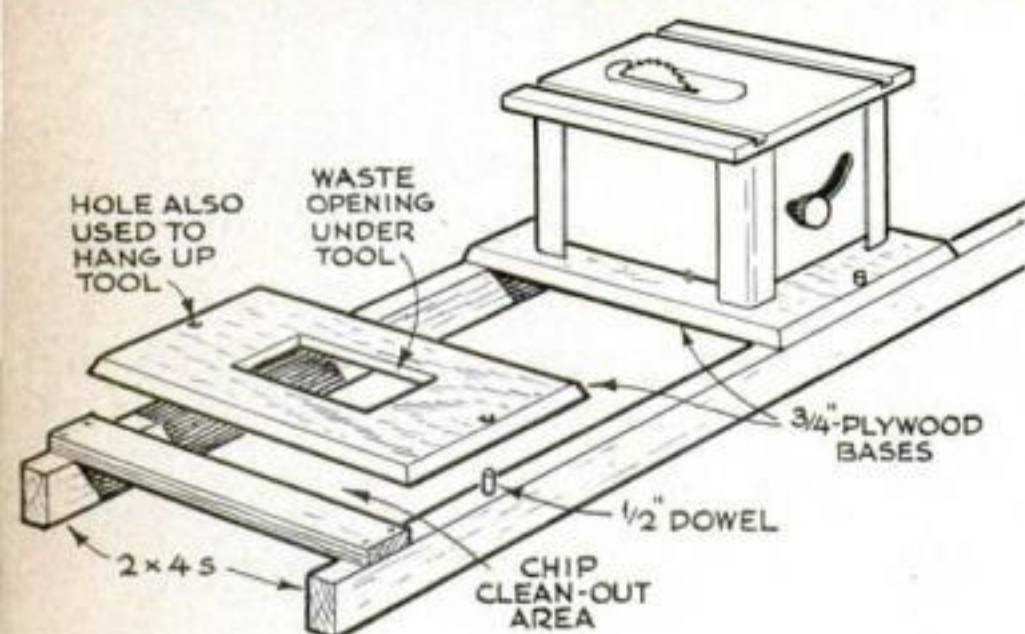
There's more to the surprise: Each of these new Compactools, as they are

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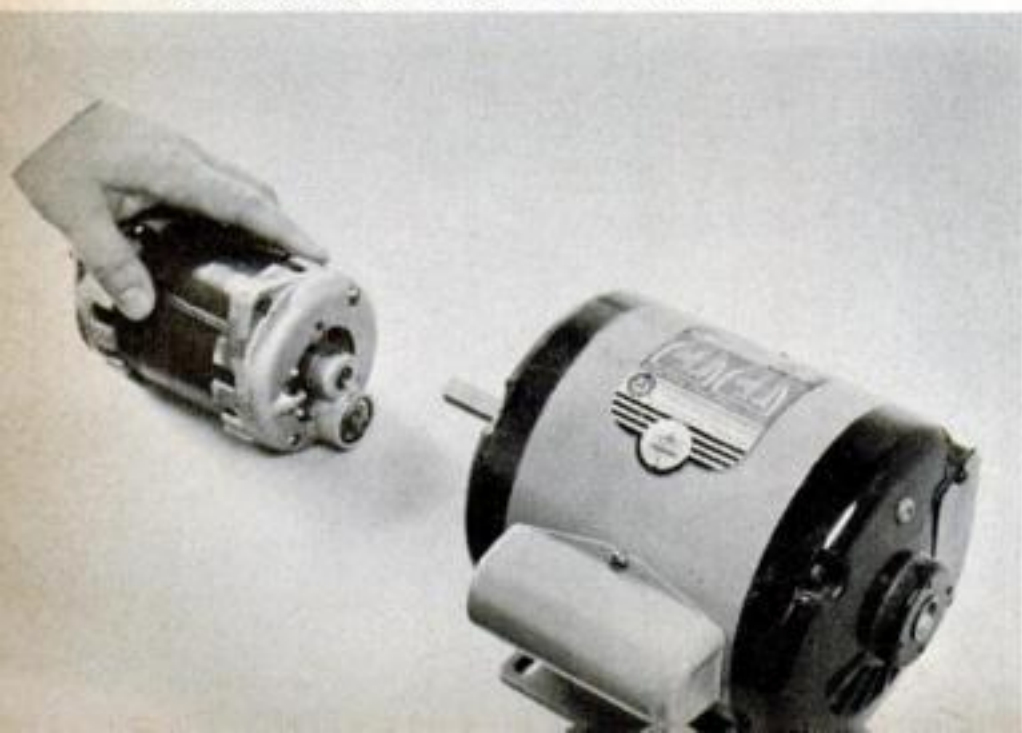


TWO-WAY SAW TILT is controlled by two rods at right angles. One pivots the blade sideways to vary cutting angle; the other tilts it up or down to change cutting depth.



YOU CAN EVEN HANG THEM UP: Mounted on small wood bases, the new compact tools can be stored out of the way on wall hooks when not in use. For quick setup, they can be dropped over pegs in a simple jig, as shown, to hold them steady as you work. Jig is just two rails with cleats at the ends. Cutouts in the wood bases let chips fall through without clogging.

COMPACT MOTOR, below, left, delivers $\frac{1}{2}$ hp., is $\frac{2}{3}$ size of regular $\frac{1}{2}$ -hp. one (right). A capacitor-start induction type, it has no commutator or brushes to cause TV interference.



called, has its own built-in motor. Each comes fully assembled and ready to go. Just lift the machine out of the box and plug it in.

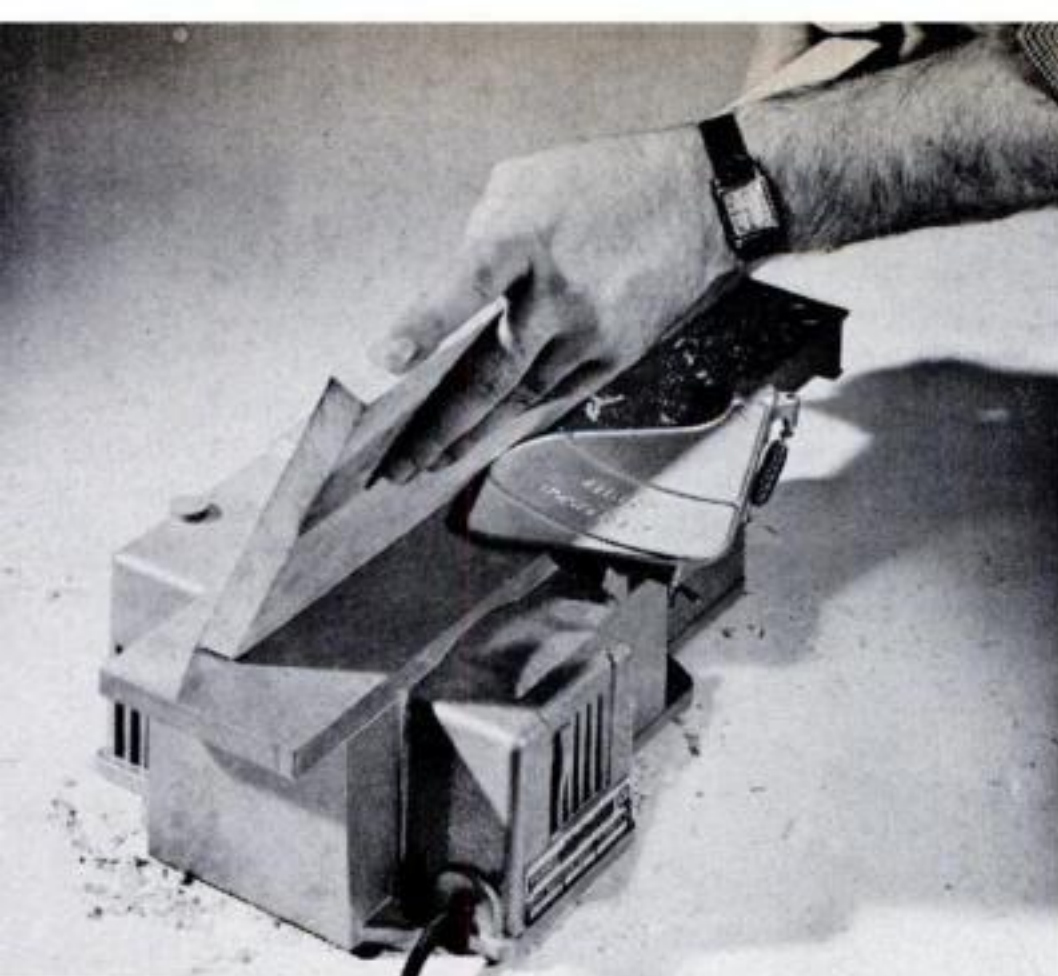
The tools are not gimmicks. Their aim, says Rockwell, is to give big-shop capacity in a small space. Their engineers were aiming at true stationary-type power tools that could be used in places other than an elaborate workshop.

"In many modern homes," a Rockwell designer told me, "dad doesn't have a basement. Even if he does, he often can't make sawdust in it—it's the family recreation room. But he can store these tools in a closet or on a garage wall and set them up in a utility room. Or he can even carry them out for use in the driveway or on a porch. Even apartment dwellers are buying them—for use in the kitchen."

It sounds great. But still there's that nagging question of size. Can a small tool really be good? Will it have the accuracy, capacity, and power to satisfy the serious woodworker?

Says Rockwell: "There's no reduction of quality." For 80 bucks—the price of each tool—there shouldn't be. But **POPULAR SCIENCE** decided to find out for itself. All three tools were rigorously shop-tested under the same conditions that would apply to similar full-scale stationary tools. Here's the verdict:

There's plenty of power. The motor built into each tool is a new slimmed-



TILTING FENCE on jointer permits bevel cuts like this. It proved a bit low for wide stock, but has holes for attaching an auxiliary wood fence. Machine's cutting speed is good.

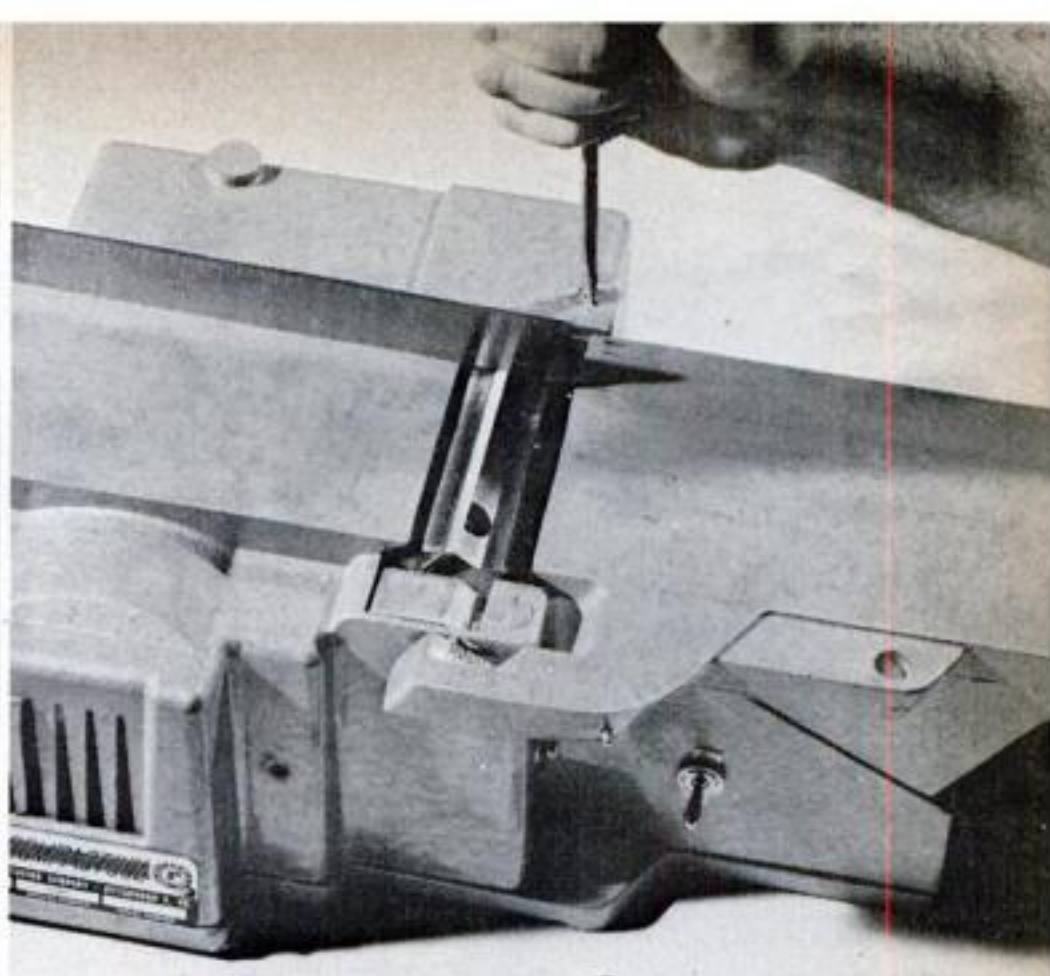
down design that delivers a husky $\frac{1}{2}$ hp., yet is only about two-thirds the size of conventional $\frac{1}{2}$ -hp. motors. This is real muscle. These tools don't whimper under load.

The motor, says Rockwell, is actually what made the compact tools possible; it had to be developed especially for them. It also accounts for what may seem at first like a fairly steep price tag. You're paying for the luxury of portable, self-contained power—and that doesn't come cheap.

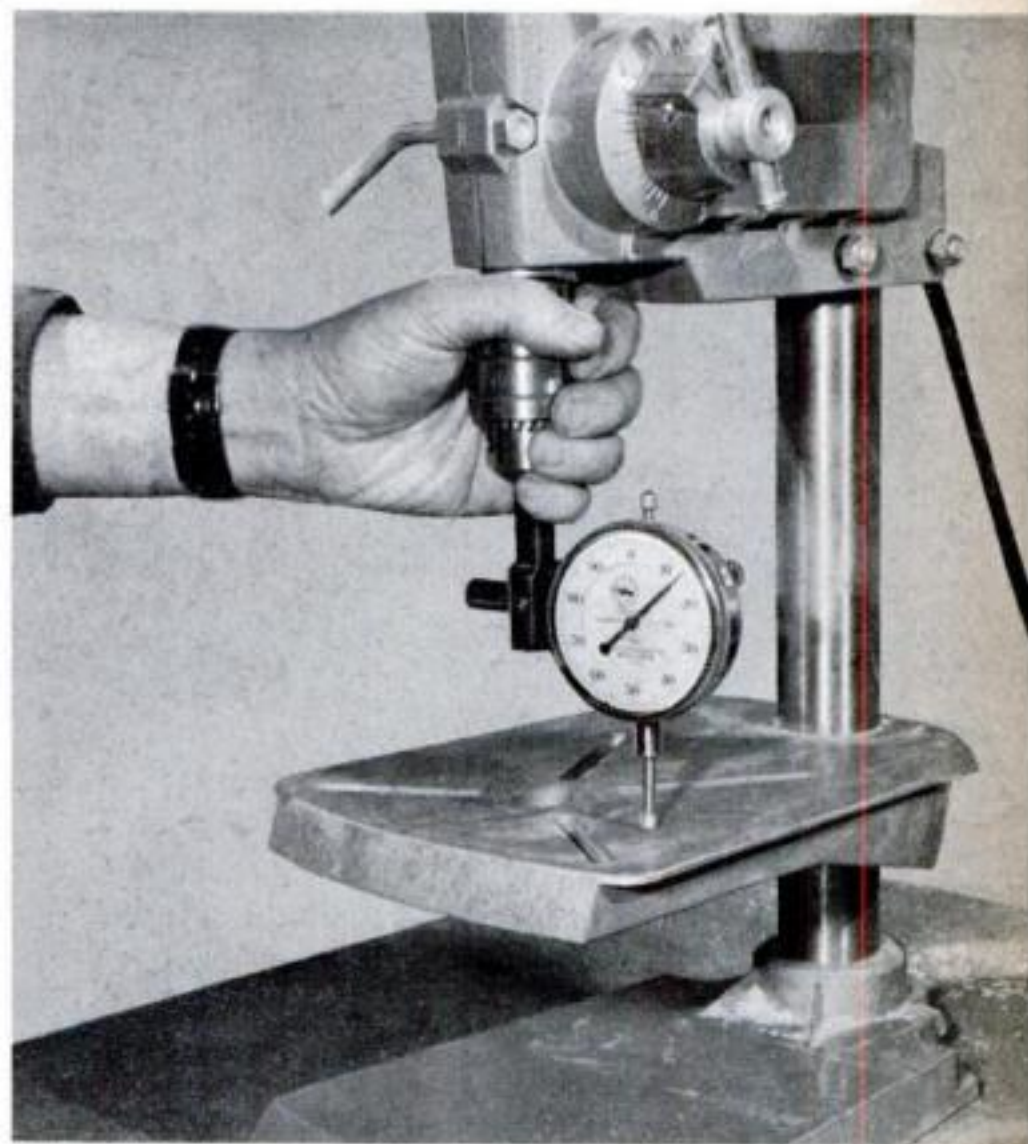
The motor's speed of 3,450 r.p.m. is just right for driving the saw directly. In the drill press and jointer, there's a novel multigroove drive belt, plus an ingenious pivoted motor mount. It eases the strain on bearings when the driven shaft runs free and tightens the belt under load when it has to pull hard.

You can plug the tools in anywhere—despite their power, the motors draw only five amps. If you should stall one—and that's hard to do—a thermal overload switch automatically cuts out until you remove the load and press a reset button. The tools are constructed largely of aluminum alloy. This makes them light—only 30 to 35 pounds each—and also reasonably rustproof for storage in a garage or other damp areas.

What the table saw will do. It's a true tilt-arbor design with, in this case, the motor tilting right with the blade. The $7\frac{1}{4}$ " blade cuts about $1\frac{11}{16}$ " deep



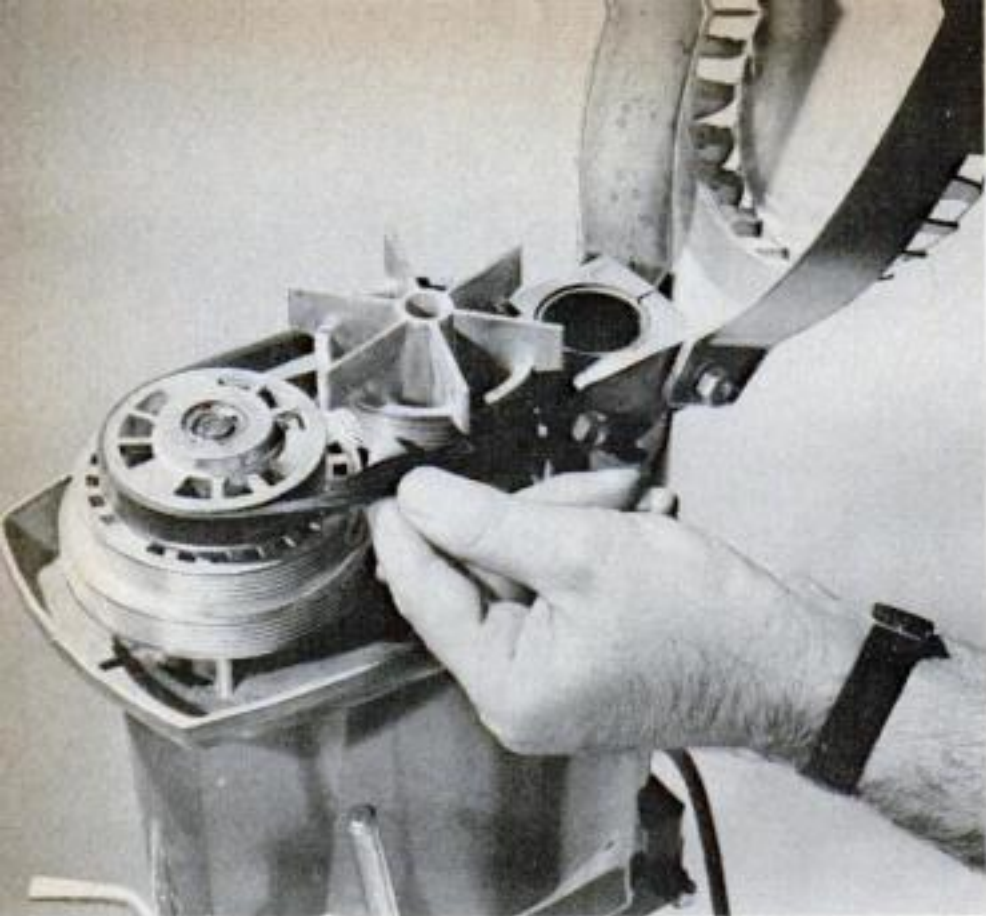
TO LEVEL JOINTER KNIVES, you raise or lower the entire cutting head by adjusting a screw. The individual knives are locked parallel in the head and require no adjustment.



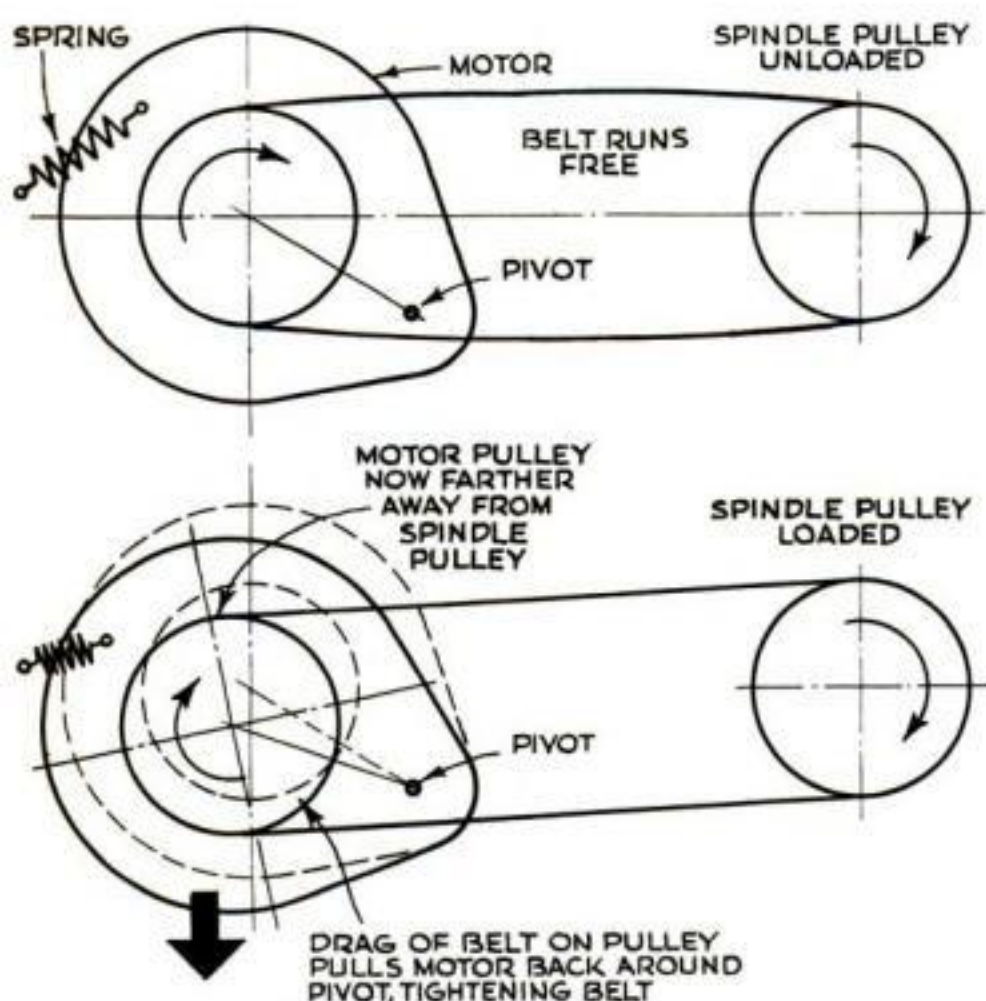
A DEMANDING TEST of drill-press table alignment was made by swinging a dial indicator held in the chuck this way. It showed a side tilt of .013"—acceptable for woodworking.

at both 90- and 45-degree settings—just right for a two-by-four. Because its pivot axis is offset, the blade rises as it tilts. The saw can rip to the center of a $9\frac{1}{4}$ " board with the fence in place. Add table extensions that increase the surface to 14" by 24" and it can split a $20\frac{1}{4}$ " width.

CONTINUED



NEW MULTIGROOVE BELT, used in drill press and jointer, has tiny ridges to match pulleys. Thin and flexible, it has a tighter grip and wastes less power than conventional V belts.



INGENIOUS DRILL-PRESS DRIVE tightens its belt under load for more power. With no load, pivoted motor is held loosely by spring (top). As load increases, motor pulls harder on lower half of belt and tries to twist toward the spindle pulley. But since its pivot point is above the line of force, motor actually swings *away* (bottom), stretching the belt tighter.

Under timed tests, the saw whizzed through 2½"-wide, 13/16" hard maple flooring in 1 3/5 seconds—just as fast as my own 1-hp., 10" table saw. On ripping, my 10-incher sliced the same maple flooring at the rate of four seconds a foot. The Rockwell took only a third of a second longer and wasn't even bolt-

ed down. It also sawed two-by-four spruce cleanly at 45 degrees in 3 4/5 seconds. These add up to mighty impressive performance.

Any drawbacks? On the saw tested, the table grooves proved parallel with the blade to within 1/125"—about what you'd expect on any good saw. The miter-gauge bar seemed sloppy in the grooves, but still produced good miter joints, one after the other, in 1¼" stock. The blade also cut so easily the work could be handheld without creep.

It's easy to crosscut a 6" board, or even wider ones, with the miter gauge reversed. But try to cut the end of a four-foot board at 45 degrees and you say good-bye to accuracy. You just can't manage such stock on a small table.

Tilt and depth adjustments are handy, thanks to big knobs and angle stops at 45 and 90 degrees. A single knob supposed to lock both settings fails badly, however. It's too small and too near the table to afford enough handgrip. Both adjustments can be altered even with this lock knob tightened.

Also inadequate is a slot in the end of the motor shaft that you're supposed to hold with a screwdriver when changing blades. A wood block wedged against a blade tooth does a better job of locking the arbor against turning.

These are fairly small quibbles, though. The saw proved that its smallness does not affect cutting speed or accuracy. It does limit, to some extent, the size of stock that can be handled easily. Within its working range, the saw is a saucy and precise little tool.

Why a jointer? It may seem odd to find a jointer included in a line of compact home tools; this is considered a fairly advanced piece of shop machinery, and most experts look askance at anything smaller than a six-incher. The answer, says Rockwell, is that the jointer is the basis of accurate cabinetwork and, after the saw, is the next logical tool you'd want for cleaning up saw cuts and jointing them square. Sales seem to confirm their judgment—the jointer sells next best to the saw.

Belt-driven at 4,100 r.p.m., the three 4½" blades make 12,300 cuts a minute. A single pass produced a good surface on soft wood; on maple flooring, the

[Continued on page 210]

Why You Must Cure CONCRETE

By Bob Gilmore

WHILE you're reading this article, somewhere another piece of concrete is going bad. It may have been given the best of everything—the cleanest sand and gravel, the purest water, the freshest portland cement. These ingredients may have been proportioned perfectly, and left in the mixer for the ideal interval.

Yet, in spite of such pains, the walk, the wall, the foundation, the floor is on its way to becoming a weak and crumbly failure, full of surface cracks, ready to flake away after every freeze, to erode under the touch of acids, alkalies, and salts, to wear away swiftly under foot or wheel traffic, to let water through like a sieve.

That's because something got left out. Something called the *cure*.

There should be no doubt about this cure. It lets concrete develop the ultimate strength to resist age and ailments. It consists of a week of "wet-nursing" to keep the concrete from drying out too fast—from the time it leaves the mixer and begins to harden until certain gradual changes in its chemistry have been given a chance to become well established in its mass.

What is concrete, anyway? Concrete is actually a man-made, molded stone. It's mostly sand and gravel (or slag or cinders) surrounded and tied together by a tough mineral cement.

This portland cement comes out of the sack as a superfine dust. It turns to a slithery paste, or gel, when water is added. Seen through an electron microscope the gel is a three-dimensional swamp of interlocking and overlapping leaflets and platelets shot through everywhere with bubbles and channels of water and air.

If suddenly all the water should be sucked away, the cement would remain a dried, delicate, spongelike structure incapable of much compressive strength or intergranular grip. Obviously, it would seem sensible to replace the water with something that would fill as much as possible of those wide-open caves and tunnels. Curing does this.

Here's how: Almost from the time water and portland



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cement combine in the mixer, a merger begins building between the water's hydrogen-oxygen content and the cement's silicates of calcium and aluminum, and oxides of iron.

Hydration does it. The term for this chemical merger is "hydration." Its result is a blend of tough, solid hydroxides, mostly of the calcium type. These build up as a sort of incrustation, or lining, on the walls of the submicroscopic caverns. You can liken them to the deposits in an old teakettle, or the scale in a boiler tube or iron water pipe.

The process of hydration uses up a great volume of water. Thus, though hydration may beef up the cement structure by filling its pores, it can do so only while water remains. If something is done to hold in all, or nearly all, of the original mixing water, concrete will cure to the strength you expect of it. To fulfill the superstrength requirements of such structures as bridges or large public buildings, additional water must be kept soaking in. Or a special chemical must be added to the mix at the beginning.

When concrete is abandoned without provision for curing, only such an undeserved stroke of luck as a drenching drizzle or dripping fog that begins immediately and hangs on for a week can save the job. Otherwise, you'll probably wind up with substandard stuff that a dog might kick apart, especially if a warm sun and brisk breeze combine to hasten evaporation of the water in the original mix.

Start the job right. Even the best of curing methods may do little good if dry soil or form lumber suck the water out of concrete. So all forms made of wood or other absorptive material should be oiled or otherwise made waterproof. Also, any rock or soil on which the fresh concrete will rest should be saturated well ahead of pouring time, then sprinkled again just before the pour.

This last-minute sprinkling is especially necessary in hot weather. It helps cool things down to prevent the "snap" set that heat may bring about. Occurring most often on hot, dry days, a snap set can come so swiftly that any cure is short-circuited and there's no chance for surface finishing.

Where concrete is poured over a tamped fill of rock, gravel, or cinders that will drink away water rapidly, even soaking and sprinkling can't help much. Here you need a water-stopping membrane over the thirsty ground—polyethylene film, lapped courses of roofing felt or vaporproof building paper, or stiff panels of tough, asphalt-saturated fiber.

Only after you've sealed off such subsurface water losses can you concentrate on the various kinds of cures.

Some old-time cures. The simplest and most desirable kind of concrete cure might seem to be a misting, fogging-down, or flooding from a garden hose. The trouble with such a cure is that it's too easy to go away and let the concrete dry out between wettings—almost as bad as no cure at all.

So the problem of neglect may be solved by a cure called "ponding." This calls for leakproof dikes of earth to hold in a hosed lake that will cover all the new concrete surface. The cure is perfect so long as no leaks develop in the dike.

Another standard old-time cure is covering the fresh concrete with earth, sand, straw, rags, or burlap. The covering is kept constantly wet by sprinkling when necessary.

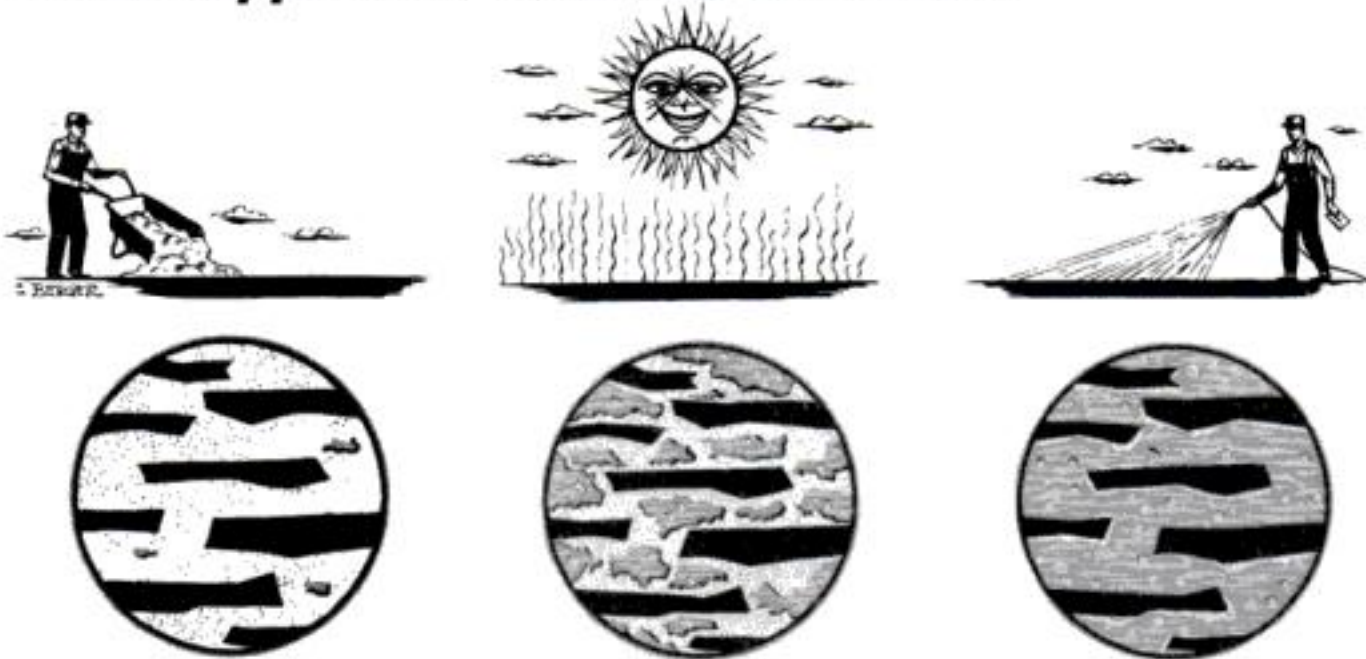
There are two drawbacks: 1) some of these coverings may stain the concrete surface; 2) wind can blow away the straw or burlap unless you weight them down.

Cover cures. For years, many small contractors have cured concrete by means of rolled-out strips of building paper—to be re-used later as a vapor barrier under sheathing or subflooring. Such a surface sealer is effective only if all edges and laps are taped or weighted, and if traffic doesn't puncture the paper while the cure is in progress.

The same puncture problem must be considered if you use the more-recently popular polyethylene film as a surface sealer. Here lapping is usually not necessary; the poly film comes in folded single-sheet rolls of 1,000 square feet or more in size.

Poly film costs about three cents a square foot—more than cheap building papers but less than the cost of the best. However,

What happens to concrete as it dries



In freshly poured mix, particles of cement are surrounded by air bubbles and channels of water.

Fast drying prevents chemical action, leaves a porous, spongelike structure that will always be weak.

Curing permits a chemical process that builds deposits on cement particles, completely filling the voids.

if you handle the film carefully, you can keep it clean and unpunctured for further use as waterproof wraps or covers in the shop, garden, or for camping.

Cures out of a can. The cheapest cures you can buy—also about the easiest to use—are the kind that come in containers, ready to be put on and put out of mind. They'll average about one cent a square foot. These liquids spray, brush, or roll onto the concrete to seal its surface against evaporation loss. There's an asphaltic coating that stays to become a primer for asphalt- or asbestos-tile flooring adhesives later on. Watch out, though, if you use any such black-topping cure on a hot and sunny day. You should rig sunshades beforehand to forestall the premature set concrete can take when dark colors help its surface drink in heat rays.

On the other hand, black cures can help you in cold weather when their heat-absorbing capacities may prevent a ruinous freeze in the fresh mix. (Another help for cold-weather pours can be calcium chloride. Stir in the dry chemical at the rate of one to no more than two pounds per sack of cement. Its swift-set action will help defeat the creep of cold. Count on calcium chloride only as an accelerator, however, and never as an antifreeze.)

Some surface cures have a wax base and must be scrubbed or dissolved away before most flooring adhesives will stick to the slab. Others are resin-based and won't interfere with the grip of any flooring stickums.

Among these waxy or resinous surface sealers, some have fugi-

CONTINUED

tive colors—usually reds or greens that show even coverage during application but fade to invisibility in a few days. Others are a permanent white that carries a bonus of reflective pigment to help keep new concrete cool in bright weather. And there are also water-clear surface sealers—waxy or resinous, and with or without minerals and/or chemicals. These permanently “case-harden” the concrete by setting up hard and tough capillary tunnels and pores in its surface. The hardening sealers are called for only where there’ll be constant pounding traffic on the slab, as in warehouses and factories.

Windproofers. Sometimes a slab must be poured and finished on a warm and unusually windy day. Under such conditions, water loss should be sealed off sooner than usual—almost from the moment the concrete is poured.

For times like this there’s a special anti-evaporation sealer that you spray on just as soon as the concrete has been “screeded,” or struck off level. It’s a clear resin (Thompson’s Water Seal, made by E. A. Thompson Co., Western Merchandise Mart, San Francisco 3). It’s best known as a waterproofing agent for wood, dry concrete, masonry, or fabrics. After it’s applied and wet glaze has gone from the new concrete it covers, floating and troweling operations are carried on as usual.

Integral cures. Beyond all cover cures and surface sealers, there’s one other kind of inner cure. Some say it’s the Cadillac of cures. One thing is sure: This type is truly the simplest—you add it along with the water, cement, and aggregate when you load the mixer. Then you forget it.

It’s more than a cure, really—it adds dense resins and minerals to waterproof and strengthen the cement throughout, not just on its surface. Concrete mixed with it as an additive is also more plastic—more easily placed and patted into perfection—than ordinary mixes.

In addition, less original mixing water is needed to make a batch pourable. Thus the cement will set up with fewer submicroscopic caves and tunnels within its mass, ending up as the densest, most impermeable, longest-lasting concrete you can get.

Only on the brightest of sun-struck days need anything be added to such an integral cure to bring the desired result. Then it may help to spray on a white heat reflector to cool the surface and slow the chemical set.

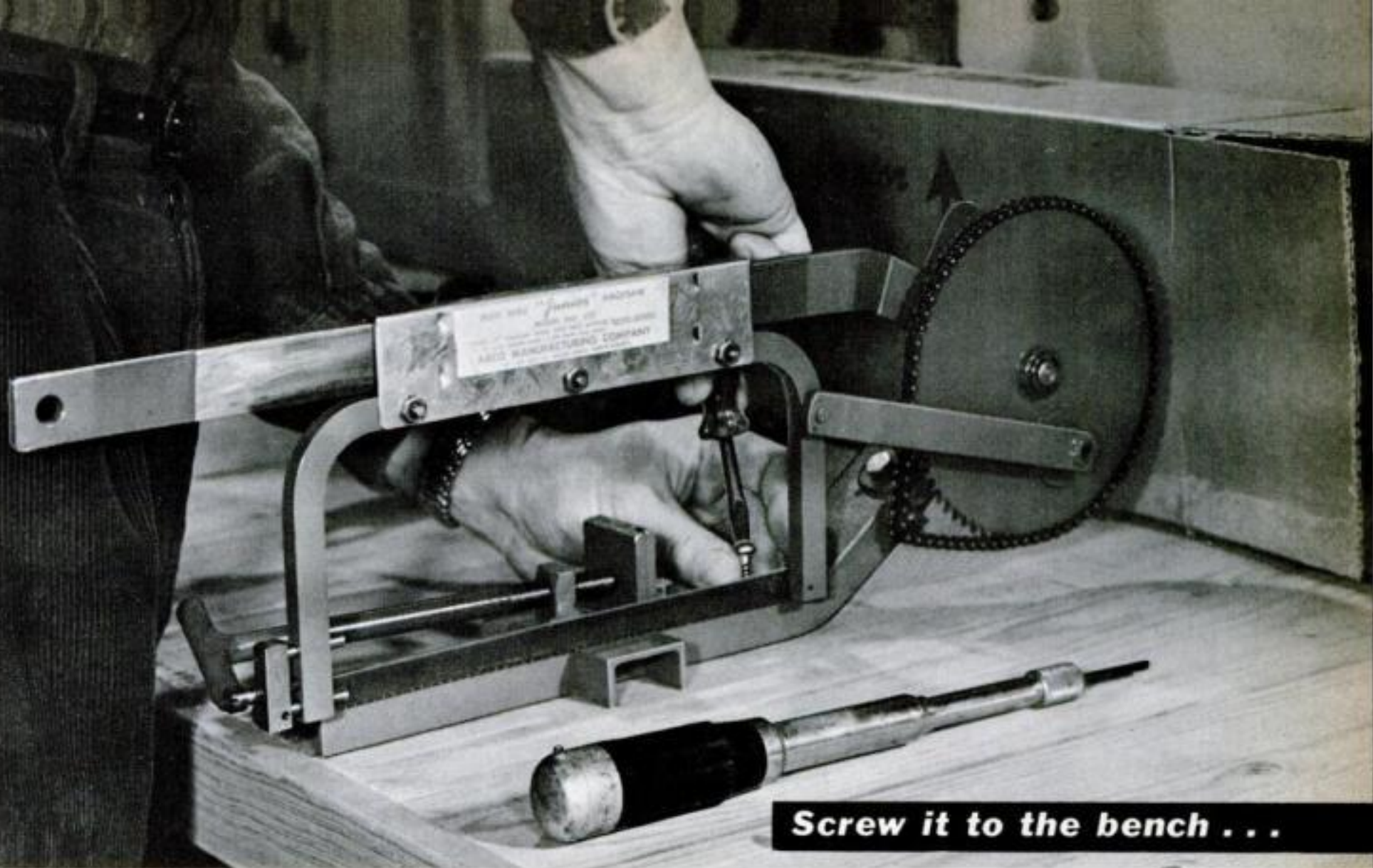
For an integral waterproof curing additive, you’ll spend about \$2.75 extra per cubic yard. This will come to something like three or four cents a square foot for a 4” slab, or a top total of \$17 for a two-car, 20’-by-22’ garage slab. At the other end of the scale, a surface sealer sprayed on the same slab will cost about \$4.50.

Take your choice. With the facts about concrete curing collected and compared, the question should never be *whether*, only *which*.

And that decision should depend on the conditions the concrete will have to live under, the things you expect of it under those conditions, and how much you can (or care to) pay to get the desired results.

You’d be foolish, for instance, to put in a \$10,000 swimming pool without investing a small fraction of that cost in the insurance that an integral waterproofer cure gives.

You’d be just as foolish, on the other hand, to use the same (or any) curing agent when you’re pouring concrete for fence-post footings in damp soil. ■ ■



Screw it to the bench . . .

The Hacksaw Your Drill Can Drive

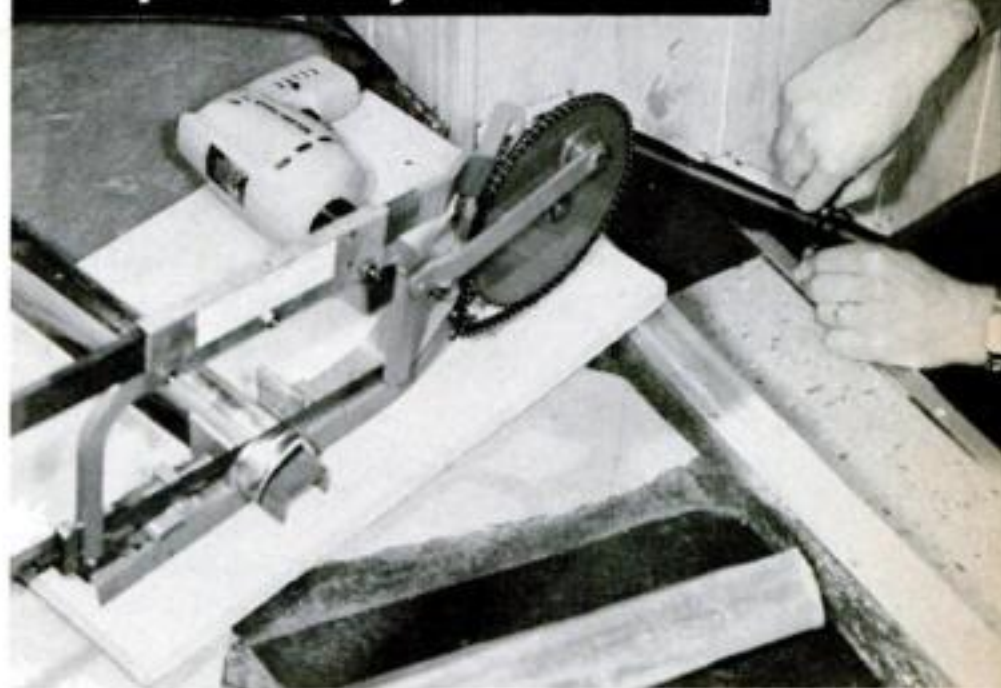
**You now can do simple
metal-cutting jobs with ease.
Here's just the tool for it**

By Phil McCafferty

EVERY man who ever dreamed of inventing a tool will mutter, "Why didn't I think of that?" when he examines a new $\frac{1}{4}$ "-drill accessory that is just about as clever and functional as they come.

It's a power hacksaw. It is as fundamental and free of gingerbread as a

**. . . or mount it on a board
for portability**



Model T Ford. Even the name plate is utilized to tell you which blade to use for what. And its reasons for being seem equally practical. The maker says it was developed for people who have: 1) a moderate need for hacksawing; 2) a $\frac{1}{4}$ " electric drill; 3) no desire to put out the money for a power hacksaw *and* a motor.

I've just put the Iron Mike saw through its paces. Frankly, I was skeptical. Too often, $\frac{1}{4}$ "-drill accessories are simply gadgets, not dependable tools. But if

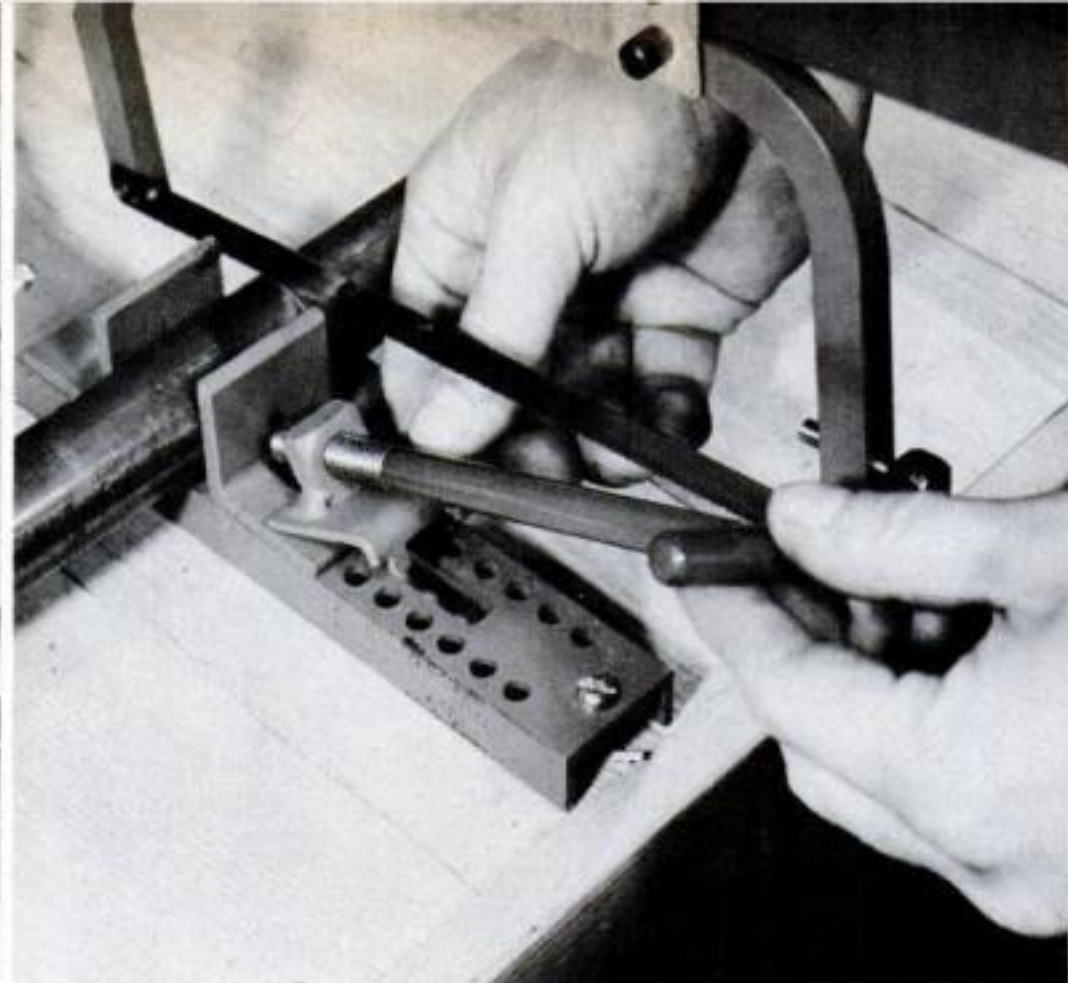
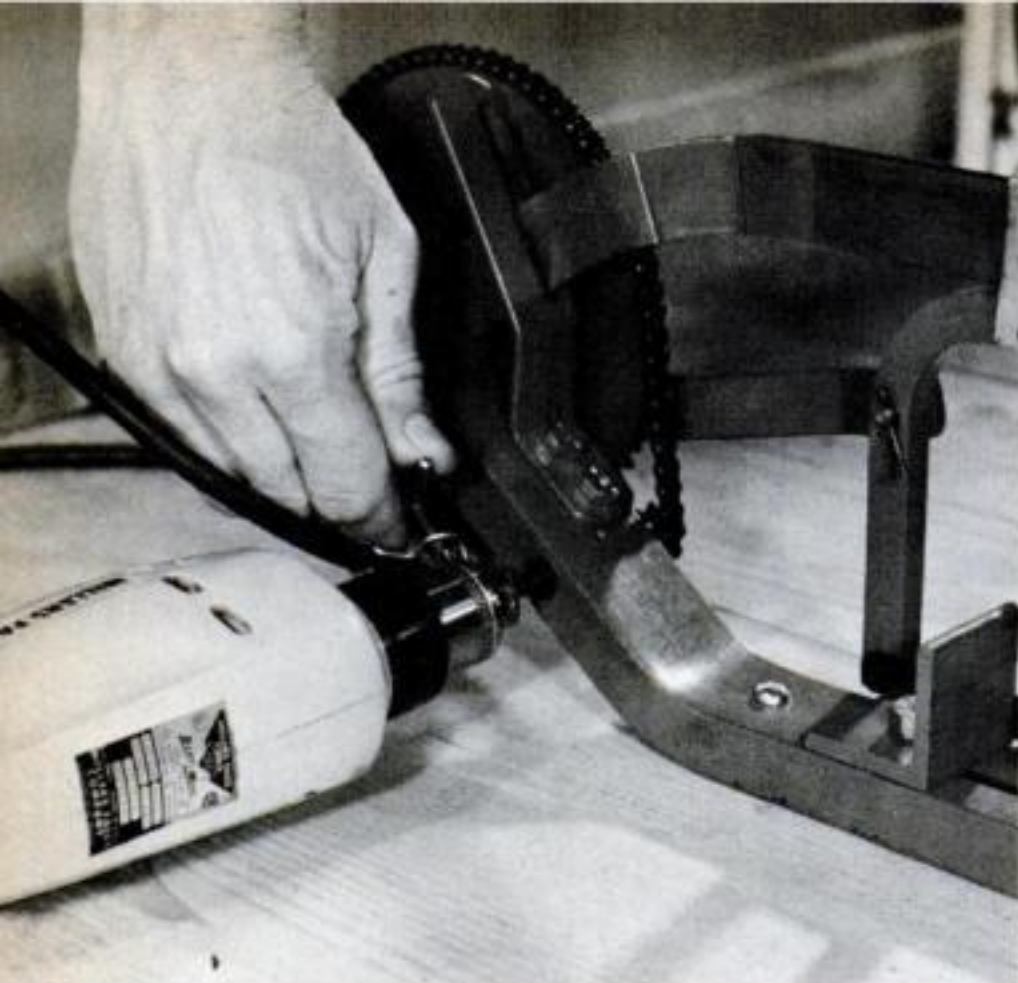
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POPULAR SCIENCE

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AMPLE POWER: Test showed that $\frac{1}{4}$ " drill loafs along to reciprocate the blade at 130 strokes a minute. Chuck is clamped on shaft through saw frame. Small pinion drives big sprocket with roller chain. Drive-shaft bearings are nylon;

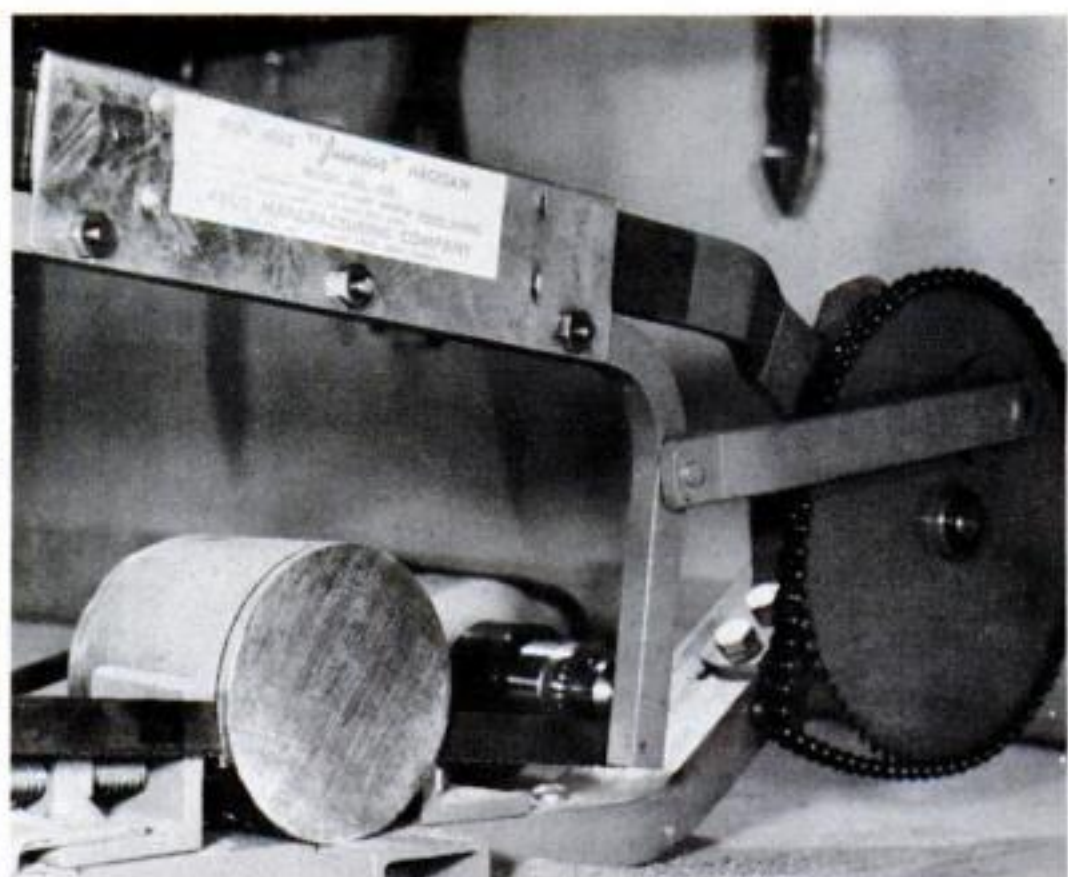
large sprocket has Oilite bearings. Bracket on frame-guide overarm stops cutting at the end of the stroke. Steel angle (above) is a simple and effective vise which is adjusted by placing a forked clamp in different holes.



CUTTING COMPARISON: Using a standard hand hacksaw, you can do an average job in about $\frac{3}{4}$ the time machine takes. More weight on overarm speeds machine up. But why bother? Machine works unattended. You do something else.

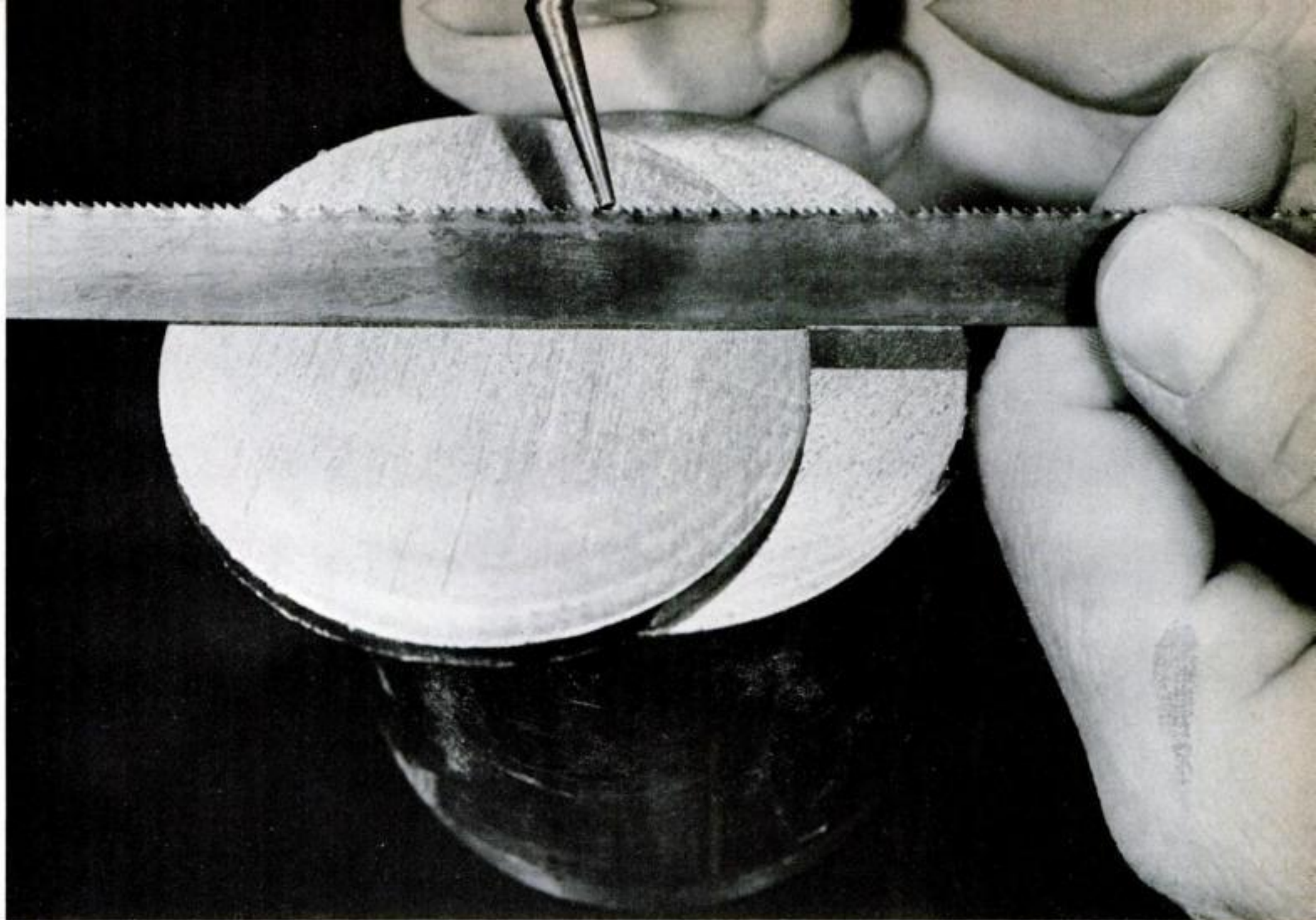
there was some easy way to beat hand hacksawing—in my book, one of the few really unpleasant chores of home workshopping—I was for it.

Ready for work. The maker made one immediate score with me. I opened the box and found the saw completely assembled—even to a properly tensioned blade in the frame. No bag of hardware, no assembly instructions. Just screw it down and go to work.



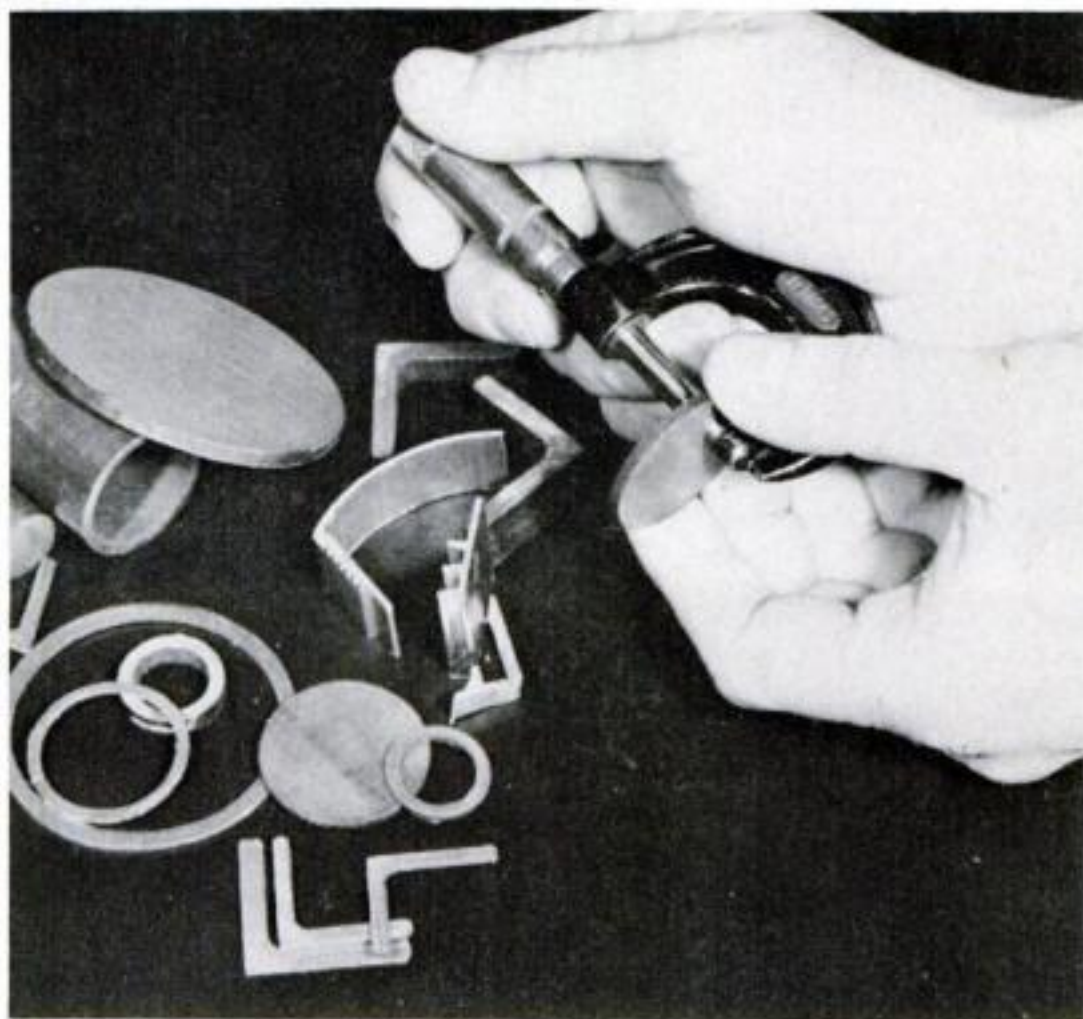
ON BIG STUFF, however, the Iron Mike walks away from a hand hacksaw; you'd soon tire and give up. Galvanized-steel yoke holds reciprocating frame on the overarm. It is lined with bronze wear shoes, lubricated by felt wick.

With the same diabolical pleasure one gets from trying to peg the speedometer of a brand-new demonstrator, I tightened a chunk of tough, heat-treated alloy-steel tubing in the vise. (I'd tried sawing this by hand and it shucked teeth off the blade like a hog eating corn off the cob.) Although I'd read the Iron Mike instructions, it took a while for the fact to soak in that it wasn't even necessary to attend the saw. It cuts all by itself! It sliced

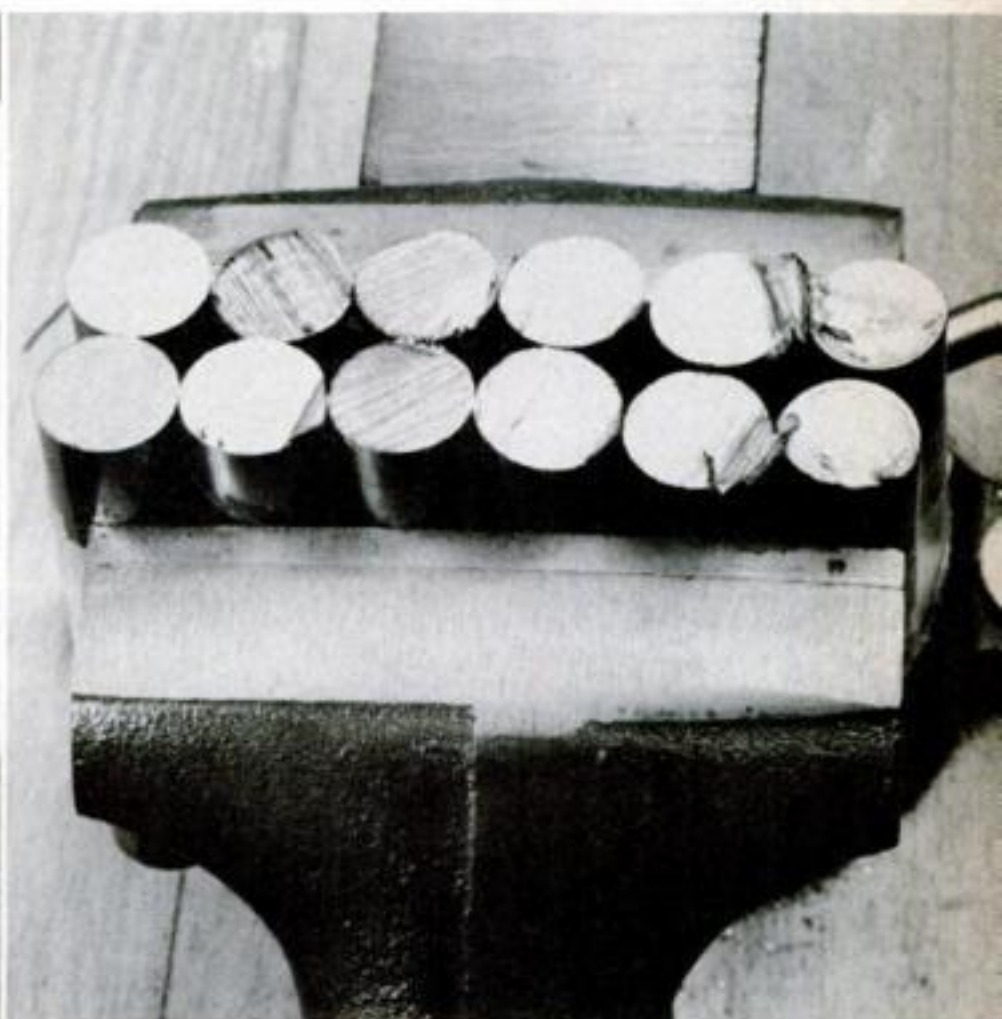


GOOD BLADE LIFE: Blade shown had made two cuts through 2 $\frac{3}{4}$ " steel bar (cutting teeth are to the left of punch). Series of tests indicated

that the machine may give about 3 $\frac{1}{2}$ times the blade life that you'd get in hand-cutting solid materials—even more on tubing or pipe.



SLICES SO THIN the material bends—that's one thing it will do. Micrometer showed that coin-thick slices of 1 $\frac{1}{2}$ " c.r. steel bar were parallel within .0025". Note the clean cut of the aluminum extrusions in center of photo.



BETTER FINISH, FEW BURRS show on Iron Mike's cut, far left. Others, in order, were made by hand hacksaw, bandsaw with metal-cutting blade, vibrator saber saw with metal-cutting blade, abrasive cutoff wheel, and bar shear.

CONTINUED

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through the tubing without complaint. The cut was smooth and the blade ended up in excellent condition.

The specs said 3" bar could be cut (actually it will take 3"-by-4" oblong bar or shapes if you clamp them upright), so I dug into the scrap box for the biggest bar I could find. This was a chunk of medium-carbon cold-rolled, steel, 2 $\frac{3}{4}$ " in diameter. I suspected that the cut would not be square and that a cut so rugged would overload the motor.

I was wrong on both counts. Straightness was almost perfect. The first cut left a new plastic-cased drill cold after 40 minutes of continuous sawing. I then tried a metal-housed drill. It got warm, but nowhere near as warm as it does when used for drilling.

Taking a critical look. Finding genuine shortcomings in this well-built saw was difficult. A swivel vise would be nice. I found, however, that work can be blocked in the vise for angle cutting. Blocking, incidentally, is the secret of getting twice the mileage out of the blade. Only the blade's front 4" (the saw has a 3" stroke) is used. Blocking in front of the work allows use of the rearward half of the blade. The fairly narrow vise jaws make it difficult to prevent long stock from sagging while you clamp. I fastened a work-support block on the right side of the vise.

The exposed chain gives every appearance of being dangerous. Experimenting with a finger-size dowel, however, I found it virtually impossible to catch it between the sprocket and pinion. The space is too small. The eccentrically driven arm knocks anything away that gets close to the chain. Still, building a chain guard would be time well spent.

No provisions, save a hole punched through the overarm, have been made for weighting the blade. While no weight is exactly right for thin aluminum shapes, up to 2 $\frac{1}{2}$ pounds can be used for heavier cutting jobs. The maker suggests clamping a scrap bar to the overarm or hanging a long bolt with a series of washers from the hole provided.

The all-steel, welded-construction saw weighs about 8 pounds. It measures about 3" wide, 23" long, and 9" high. The Iron Mike Junior, Model 625, is made by Arco Mfg. Co., 1701 13th Av. No., Grand Forks, N. D. It sells for \$24.95. ■ ■

POPULAR SCIENCE

90th YEAR SPECIAL



Now... in Full Color a PS Favorite

BACK in August, 1956, POPULAR SCIENCE published a fold-it-yourself booklet containing full-color reproductions of 21 wood samples—with notes on how to identify each one. Since then, reader requests for reprints have reached us in a steady flow. So here's the booklet again for those who missed it.

Cut the four color pages from the magazine (a razor blade does nicely) and fold as noted on the margins.

Knotty Pine

A long-favored, inexpensive wood for paneling and cabinet-making, knotty pine is not a type, but a name given to the lower, knot-filled grades of several types, most common of which are white pines. All are cream to yellowish brown, sometimes tinged with red, and darken substantially with age. They are usually straight-grained, easily worked, but may have loose knots, cracks and pitch pockets. Idaho white pine is often preferred because knots are small and tight.

White Gum

The light-colored sapwood, or outer growth, of sweetgum is called white gum. Often clear, off-white, it is almost grainless with some darker heartwood. It takes stain well, is moderately hard.

Red Gum

This wood comes from the same sweetgum as white gum, but is the brown or reddish brown heartwood, often beautifully figured with deep, rich markings. It is relatively cheap in the South.

Cherry

This wood is often called black cherry, wild cherry, or choke cherry. Texture ranges from fairly even to moderately contrasting depending on type of saw cut. Color varies from light to dark reddish brown with a high, distinctive luster. It takes a high finish. Strong, stiff, moderately hard and heavy, cherry has high resistance to shock and denting, but is not easy to work. Although it has rather large shrinkage, it stays in place well after seasoning. Cherry grows throughout the East.

THIRD: FOLD HERE TOWARD YOU

SECOND: FOLD HERE AWAY FROM YOU (THIS SHEET ONLY)

POPULAR
SCIENCE
MAY 1964 Monthly

21 Useful Woods

**How to
identify
them**

White Oak

One of the toughest furniture woods. The open grain, however, requires filling for a good finish. Wood is brown with reddish tinge, has fairly high shrinkage. It comes mainly from the East and South.

Red Oak

Two main hard types — sugar and black — vary from white to light reddish brown. They are stiff, strong, usually straight-grained with uniform texture, but shrink greatly, need good drying.

Bird's-Eye Maple

A variety of hard or sugar maple in which the grain produces small, eyelike swirls. The overall honey color has light and dark flecks. Other figured maples are curly and wavy.

Walnut

Usually called black walnut, this wood is a popular choice for fine furniture, either modern or traditional. The grain is straight but moderately prominent; the color varies from light to dark chocolate brown, with occasional deep, almost black streaks. Walnut is hard, heavy, strong, resistant to shock and denting, yet relatively easy to work. It has low shrinkage and high stability, and develops a fine, smooth natural finish. Walnut grows from Vermont to Great Plains and south to Texas.

Birch

One of the most widely used cabinet woods. It is light tan to reddish brown in color, and has a fine, close-grained, uniform texture that takes a beautiful natural finish. Hard, heavy, stiff, strong, highly resistant to shock and denting, birch is not easy to work with hand tools. The two varieties most often used for furniture — yellow birch and sweet birch — grow in the northeastern and Lake states and along the Appalachian Mountains as far south as Georgia.

Maple

FOURTH: CUT OUT ALONG THIS LINE

Honduras Mahogany

Considered the king of furniture woods by many cabinetmakers, African mahogany is medium hard, highly stable, with low shrinkage. The color is pale reddish brown.

Often a deeper reddish brown than African mahogany, this wood is slightly coarser, but has smaller pores. Grain is straight, beautifully figured.

Philippine Light Mahogany

While not a true mahogany, this import is closely similar and cheaper. Medium hard, dark brownish red, it has open pores but firm texture.

Slightly less firm in texture than dark red type, this type has same hardness and durability. It is light yellowish red.

Philippine Red Mahogany

Two main types—Western and Eastern—have a high resistance to decay and a mild aromatic odor (not the strongly spicy odor of incense cedar). Eastern type is red, often quite bright, has a fine, straight-grained, uniform texture but many knots. Western type has fewer knots but rather coarse texture, is a duller, darker reddish brown. It is softer, lighter and less resistant to shock than Eastern cedar. Both types have very low shrinkage, stay in place well, and work easily.

Ash

Extremely strong, stiff and resistant to shock, it is brown, with fairly prominent grain markings. Ash is very hard, not easy to work. Most comes from East; slightly lower-strength type grows in Oregon.

Limba

This low-cost African hardwood has many of the fine, smooth, tight-grained characteristics of expensive hardwoods. Trade-named Korina, it is blond, almost grainless and takes a high luster.

Red Cedar

FIFTH: FOLD HERE AWAY FROM YOU (THIS SHEET ONLY)

SIXTH: FOLD HERE AWAY FROM YOU AND NEST IN FIRST SECTION

Elm

Two classes—hard and soft elm—are similar, but vary slightly in weight. Both are moderately strong, stiff, bend well and have high resistance to shock. Color varies from pale to dark brown, often reddish-tinged, with light and dark stripes. Despite open pores and rather coarse texture, it stains and fills well, has a medium luster. Of the six domestic varieties, slippery or red elm (usually marketed as northern gray elm) is best for cabinetwork, having a softer, more even texture and color.

Redwood

Along with cypress, redwood is one of the most durable woods for outdoor use. Color varies from light pinkish red to dark reddish brown. Mild grain is straight with a smooth, silky sheen, fine pin knots and thin, fairly prominent dark lines. It is moderately light, strong, stiff and hard, easily worked with hand tools. Redwood shrinks and swells little, but is highly porous, requiring careful sealing. In West, it is produced mainly in California.

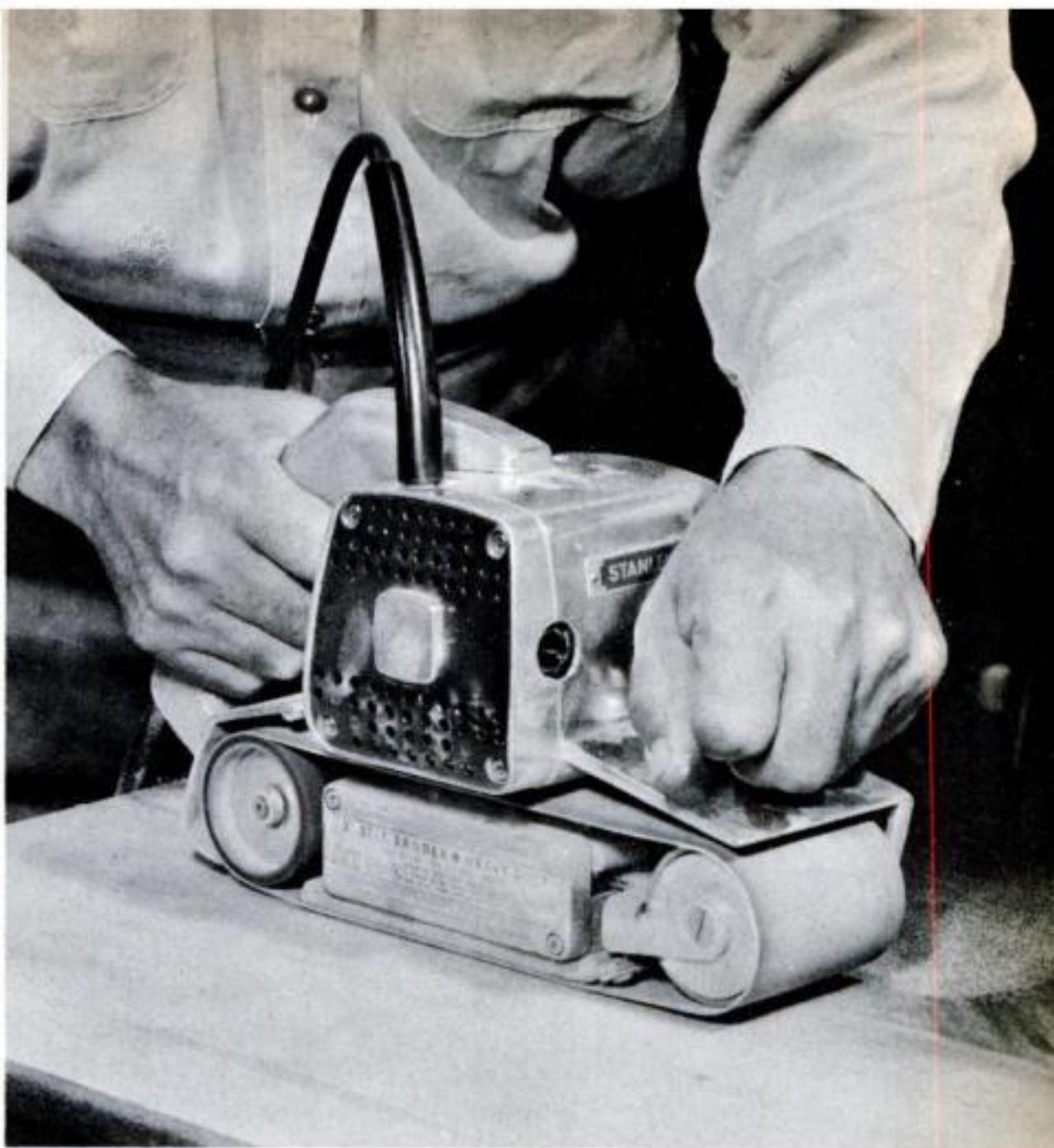
Beech

There is only one domestic type, but it is often divided into "white" and "red" beech because color varies widely from pale brown to deep reddish brown. Hard, heavy, strong, it has good resistance to shock and abrasive wear. Beech is not easily worked with hand tools, but steam-bends well and machines smoothly with power tools. There is little grain pattern, but a fine, uniform texture and medium luster. Large shrinkage requires careful drying. Grows mainly in the East.

Cypress

Technically known as bald cypress but popularly as red, yellow or white cypress, this wood is especially resistant to decay, making it a durable outdoor material available in the East and South. It has a straight, mild grain and stains well. Color varies widely from light yellowish brown to dark reddish and chocolate brown. It is moderately strong, hard and heavy, but works easily. When it contains pock marks caused by fungus decay, it is sold as pecky cypress for paneling.

How to Choose the Right Coated Abrasive



By Jerry Parker

SUPPOSE you've just made a wooden table and want to give it a smooth finish. You go down to the hardware store and say to the clerk: "I want some sandpaper, please."

If you're up on your coated abrasives, however, you don't stop there. You specify: "Give me six sheets of garnet paper, 120-grain, C or D weight, open-coat."

While the clerk gets the sandpaper, ponder the fact that you might be shopping for "sea-shell" paper. Sandpaper apparently acquired its misnomer from early man's use of sand to smooth primitive tools. Actually, the first record of a coated abrasive dates from the 13th century when the Chinese bonded crushed sea shells to parchment with natural gums.

Coated abrasives have come a long way since then. Their list of uses is endless.

To understand how they work best, you must consider five things: kind of

abrasive, grain size, type of coating, backing, and finished form. Six important minerals are used as abrasives—aluminum oxide, silicone carbide, crocus, garnet, emery, and flint.

Aluminum oxide and silicone carbide are man-made, products of an electric furnace. Crocus may be either synthetic or natural iron oxide. Some 70 percent of coated abrasives used today are made from synthetics.

Aluminum oxide is most widely used. It is a chunky-grained amalgam of bauxite, coke, and iron filings. It is the toughest and most durable of all abrasives,

rated at 9.4 on the Mohs hardness scale (the diamond is tops at 10). This brown, all-purpose abrasive is

used on both wood and metal, but its special forte is the sanding of high-tensile ferrous metals and hardwood.

It is made under such trade names as Adalox, Production, Garalun, New Process, Three-M-ite, Alundum, Metalite, Jewelite, and Gritcloth.

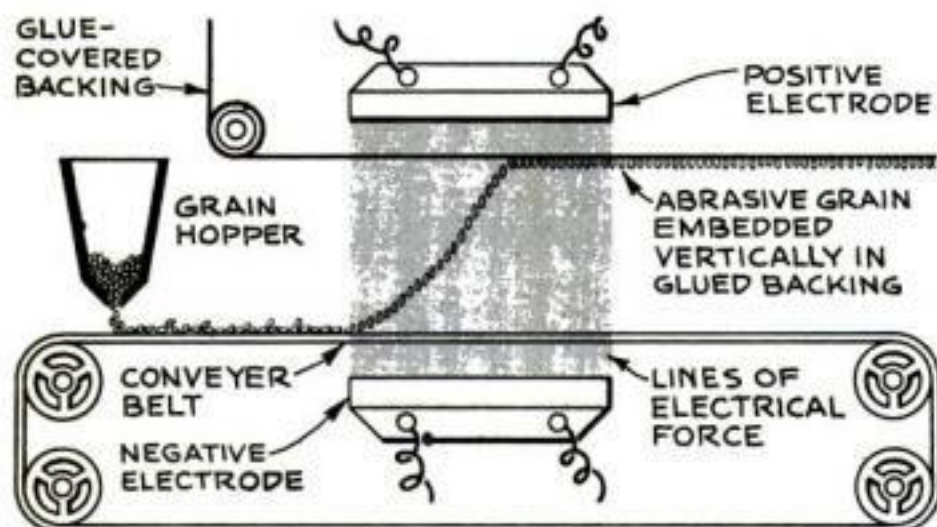
Silicon carbide is the hardest, rated

POPULAR SCIENCE

90th YEAR SPECIAL



SOME OF THE FORMS of abrasive papers are shown above—belts, disks, sheets, cones, etc.



IN ELECTROCOATING, grains are carried by conveyor between two electrodes that create an electrostatic field of up to 50,000 volts. Charge impels grains up into the glued backing.

at 9.5 to 9.9 on the Mohs scale. Produced by fusing silica and coke, it is crystalline in form and an iridescent blue black.

Which is tougher in actual use, aluminum oxide or silicon carbide, is a toss-up. Aluminum oxide seems to stand up better on heavy-duty grinding jobs because it fractures less easily. But silicon carbide is better at penetrating and cutting fast under light pressure. It is best suited to sanding low-tensile nonferrous metals, plastics, glass, ceramics, lacquers, enamels, fibrous woods, and leather.

Silicon carbide is available under such trade names as Durite, Tri-M-ite, Crys-tolon, Jewelite, Florex, Carborundum, and Gritcloth.

Crocus is very soft (6 on the Mohs scale), bright red, and is ground to a fine powder for use as an abrasive. Little used in the home shop, it finds employment in cleaning and polishing metals.

Garnet is a natural abrasive, the most important of them. A standby for the woodworker since it was introduced in 1884, it is now being supplanted in many

How to Suit the Abrasive to the Job

The best abrasive for a given job varies with the material to be cut, the backing, the grinding method, and the working conditions. Here are tips to help you choose. The table below gives the abrasives usually most efficient for the materials listed.

Aluminum oxide (AO). Excellent all-purpose, wood-metal abrasive. Brown. Comes in 9" x 11" sheets, disks, belts, rolls.

Silicon carbide (SC). Hardest abrasive. Unexcelled for wet sanding to produce super-smooth finishes. Black; in 9" x 11" sheets.

Garnet (G). Good all-around paper for hand-sanding unfinished woods. Red; in 9" x 11" sheets, sometimes disks.

Emery cloth. For polishing unplated metals, removing rust and scale. Use dry or with oil. Comes in 9" x 11" sheets and 4½" x 5½" packs.

Crocus cloth. For polishing metals to a mirror finish. Red; in 9" x 11" sheets.

Flint paper. Common "sandpaper" for hand-sanding wood and removing paint. Light tan; in 9" x 11" sheets and in 4½" x 5½" packs with assorted grits.

In the following table, *low speed* refers to hand-sanding and oscillating or orbital pad sanders, *high speed* to fast belt or disk machines, *finishing* to smoothing a coated finish such as varnish, lacquer, or enamel.

| MATERIAL | LOW SPEED | HIGH SPEED | FINISHING | MATERIAL | LOW SPEED | HIGH SPEED | FINISHING | MATERIAL | LOW SPEED | HIGH SPEED | FINISHING |
|-----------|-----------|------------|-----------|-----------------|-----------|------------|-----------|---------------|-----------|------------|-----------|
| ALUMINUM | AO | SC | SC | ASH, DRY | G | AO | SC | PRESSED BRICK | SC | SC | SC |
| BRONZE | AO | SC | SC | CEDAR, DRY | G | SC-AO | SC | COMMON BRICK | SC | SC | SC |
| CAST IRON | SC | SC | SC | FIR, DRY | G | SC | SC | TERRA COTTA | SC | SC | SC |
| COPPER* | SC | SC | SC | MAPLE, DRY | G | AO | SC | CONCRETE | SC | SC | SC |
| GLASS | SC | SC | SC | REDWOOD, DRY | G | SC | SC | MORTAR | SC | SC | SC |
| LEAD | SC | SC | SC | WHITE PINE, DRY | G | SC | SC | ASBESTOS | SC | SC | SC |
| MAGNESIUM | AO | SC | SC | GRANITE | SC | SC | SC | MARBLE | SC | SC | SC |
| NICKEL | AO | AO | SC | LIMESTONE | SC | SC | SC | SHALE | SC | SC | SC |
| STEEL | AO | AO | SC | SANDSTONE | SC | SC | SC | | | | |



SOAKING IN WATER, as above, makes some abrasives work exceptionally well. These waterproof papers resist loading and give an unusually smooth finish to coated surfaces.

jobs by aluminum oxide. Rated at 6.5 to 7.5 in hardness, garnet fractures easily, like silicon carbide, and constantly presents new, sharp cutting points.

It is exclusively a wood-finishing abrasive, used mainly in the home shop for hand-sanding. It is red.

Emery is a natural composite of corundum and iron oxide. It is jet black, very weak, and used mainly as a metal polisher.

Flint is what you think of when you hear the word sandpaper. It is the oldest of the abrasives. It is a form of quartz, light tan in color.

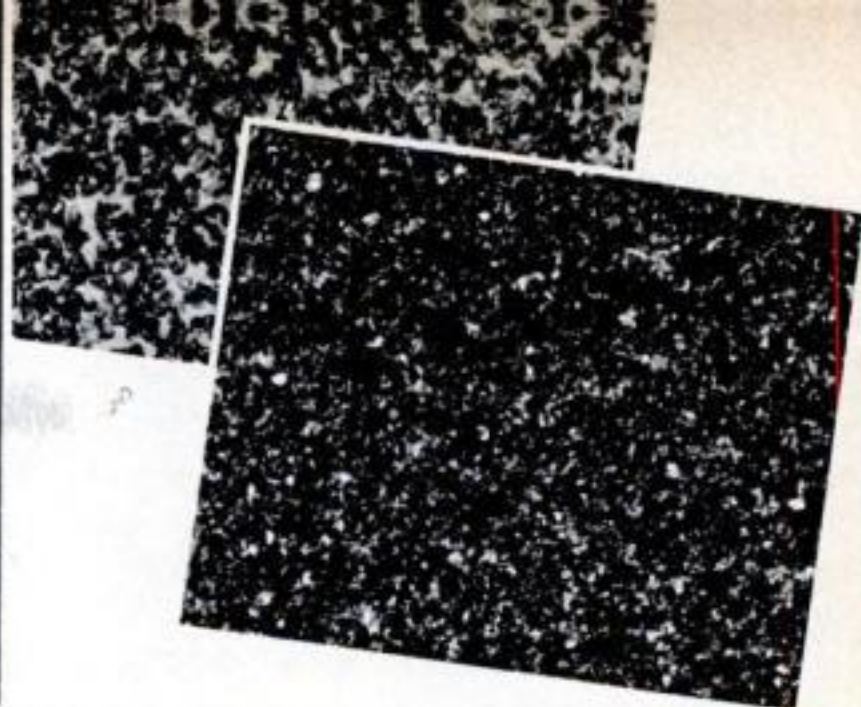
Only medium hard (6.8-7 on the Mohs scale) and lacking in durability, flint still helps out in the home shop. It is cheap, and good for small sanding jobs and for removing paint and varnish.

Tungsten carbide is up-and-coming. This is the abrasive that has long been used to put hard, sharp, durable points on tool edges and saw teeth.

The grains are bonded to disks of thin spring steel or cloth sheets. These cost much more than the other abrasives, but are said to last much longer. Karbo-Grits is one trade name.

The abrasive score card. Coated abrasives are indexed according to their grain sizes. Grain sizes range from 12, which is something like a miniature boulder, to 600, a superfine flour.

After being crushed, the grains are graded—bounced over a series of silk-screen meshes or sieves. The finest screen has 220 openings to the inch in each direction—48,400 openings per square inch. Grains or flours finer than 220 are segregated by sedimentation or air flotation.



TWO TYPES OF COATING are available—open coat, at the top; and closed coat, bottom. Closed coat has grains over entire surface. Open won't clog as fast, since chips fall out.

The Grain Sizes of Coated Abrasives

In recent years, coated abrasives have been rated by grain size in place of the old system, which used 10/0, 9/0, etc. The table below shows ratings under both systems. (Data is from the Coated Abrasives Mfrs. Institute.)

| GARNET (20-280) ALUMINUM OXIDE (16-600) SILICON CARBIDE (12-600) | | FLINT | EMERY |
|--|------------|--------------|--------------|
| EXTRA FINE | 600 | | |
| | 500 | | |
| | 400 (10/0) | | |
| | 360 | | |
| | 320 (9/0) | | |
| | 280 (8/0) | | |
| | 240 (7/0) | | |
| | 220 (6/0) | | |
| | | Extra Fine | |
| FINE | 180 (5/0) | | |
| | 150 (4/0) | | Fine |
| | 120 (3/0) | Fine | |
| MEDIUM | | | Medium |
| | 100 (2/0) | | |
| | 80 (0) | Medium | Coarse |
| COARSE | 60 (1/2) | | |
| | | | Extra Coarse |
| | 50 (1) | | |
| | | Coarse | |
| EXTRA COARSE | 40 (1 1/2) | | |
| | 36 (2) | | |
| | | Extra Coarse | |
| | 30 (2 1/2) | | |
| | 24 (3) | | |
| | 20 (3 1/2) | | |
| | 16 (4) | | |
| | 12 (4 1/2) | | |

Coated abrasives are now marked on the back according to grain size. The old marking system was simply a set of arbitrary numbers—4½, a 12-grain size; 1, a 50-grain; and so on through 10/0, a 400-grain.

Mesh or grain ratings are an infallible guide when you choose coated abrasives. For most jobs, you must use several grades, starting with a coarse form and finishing up with a fine.

In finishing wood, you might start with 60-grain, step up to an 80, and use 120 for the final smoothing. The pattern would be similar for metal, though probably you would start with a finer grain, say an 80. In smoothing paint or other fine finish, you would begin with a very fine grade, 220 perhaps, go to 320 in the intermediate stage, wind up with 400.

At the other end of the scale is floor sanding. There you might use a 30-grain first, 50 for smoothing, and 100 for the final pass.

The abrasive grains are bonded to their backing with hide or resin glue, or with modified types of either adhesive. Resins have been developed in recent years for abrasives that must withstand a great deal of heat.

The electrocoater is used to produce most high-quality abrasives. It creates an electrostatic field of 50,000 volts. This sucks the abrasive grains off a conveyor belt and embeds them in the backing equally spaced, with their sharp points stabbing upward.

Coating. Abrasives are made with two types of coating, open and closed. In an open coat, the abrasive grains cover 50-70 percent of the surface. In the closed coat, the grains completely cover the surface.

Each type has advantages. The closed coat will last longer and give more satisfaction in rugged operations. The open coat, however, is useful in working on soft, fibrous, or gummy woods and on various soft metals and plastics because it does not load up as fast. Open spaces let chips and waste fall free.

Backing. Four types are used—paper, cloth, vulcanized fiber, and combinations of these laminated together.

Paper is cheapest. It is used widely to back abrasives not requiring exceptional strength or flexibility. Most home-shop abrasives have paper backings.

The paper is made in various weights—40, 60, 70, 90, 100, 110, and 130 pounds per standard papermaker's ream. Weights are designated by letters: A for 40-pound paper, C for 90, D for 100, E for 130. There is no B grade and no letter code for 60- or 110-pound papers.

The lightest paper, A, is used for gentle hand-sanding, such as finishing contours where you need great flexibility. The stiffer C and D, the "cabinet" papers, are used for hand- or light machine-sanding. Heavyweight E paper is mostly for industrial use.

Specially treated cotton drills and jeans are used for most cloth-backed abrasives. The drills are heavier, are marked with the letter X, and are used mainly for rough work in coarse grades. The jeans, marked J, are preferred for flexibility. There is also a heavy twill backing marked H. And several makers offer an open-weave rayon fabric coated on both sides and through its mesh.

Vulcanized fiber, made of rag paper treated with zinc chloride, is a hard, sturdy, and flexible laminated backing, and has the highest strength of any of the backings. It is used chiefly as a backing for resin-bonded disks made for heavy-duty portable sanders.

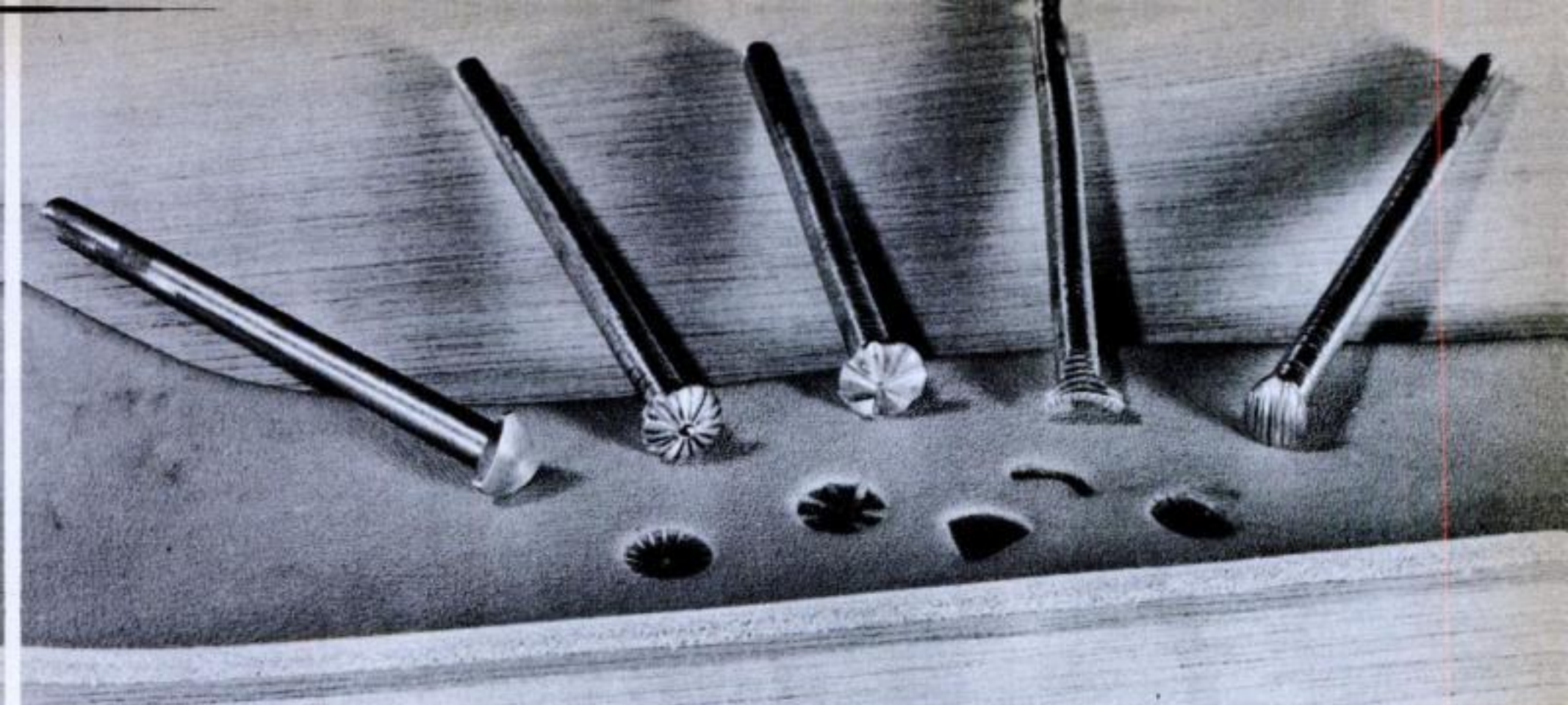
Both cloth and paper backings (except with flint and emery) are made in waterproof types to permit wet sanding with water, oil, kerosene, mineral spirits, or almost any liquid lubricant.

Finished forms. Abrasive manufacturers make about 40,000 different items in five main categories—sheets, rolls, belts, disks, and specialties. The last group includes the unusual variations employed by industry. Some of these are spiral-wound bands, spiral-wound strips, edge-slotted disks, and cartridge rolls.

Coated abrasives in the form of sheets, rolls, belts, disks, and drums are the ones most used in the home shop. Your choice will depend mainly on your sanding tool or machine.

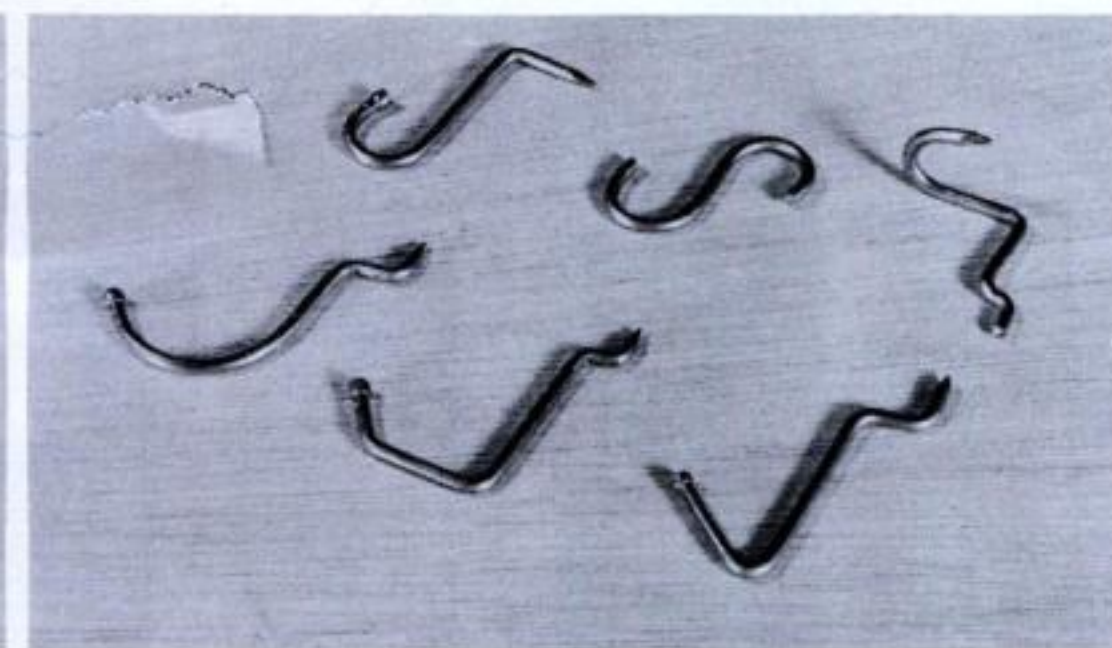
Standard 9"-by-11" sheets may be cut up for hand-sanding. Rolls are fine in magazine hand-sanders, for lathe sanding, and for wrapping special-purpose mandrels.

Smaller sheets are made for both hand and power sanders. Disks come with plain or with slotted centers to fit both portable tools or stationary mounts. ■ ■



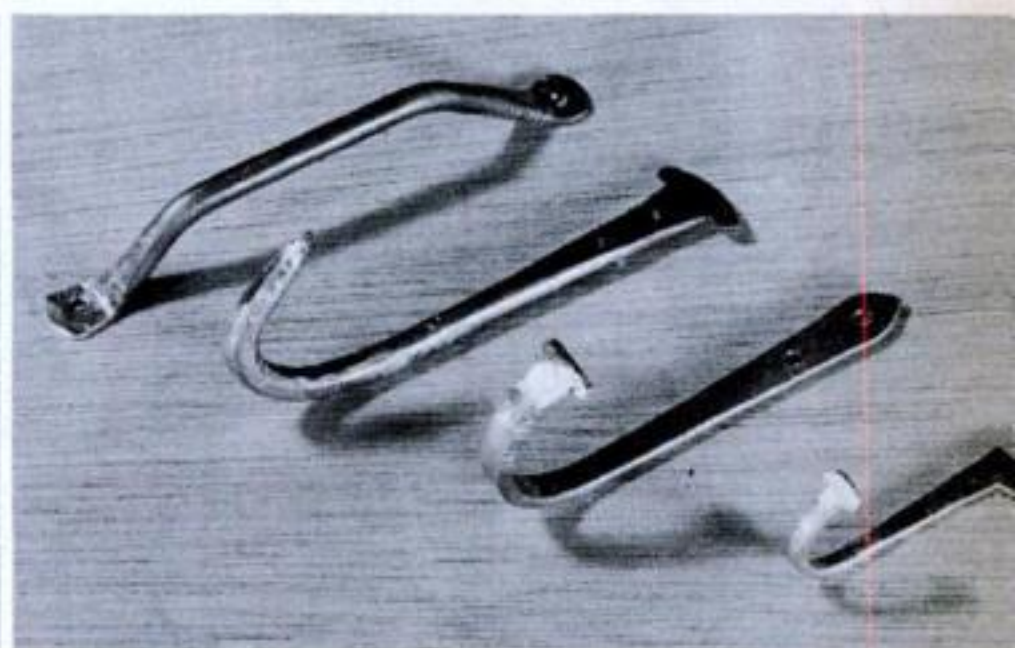
LEATHER STAMPS? Shape the nailheads with a triangular file and smooth them with emery. For design ideas, see a leathercraft catalogue.

Other Uses for NAILS



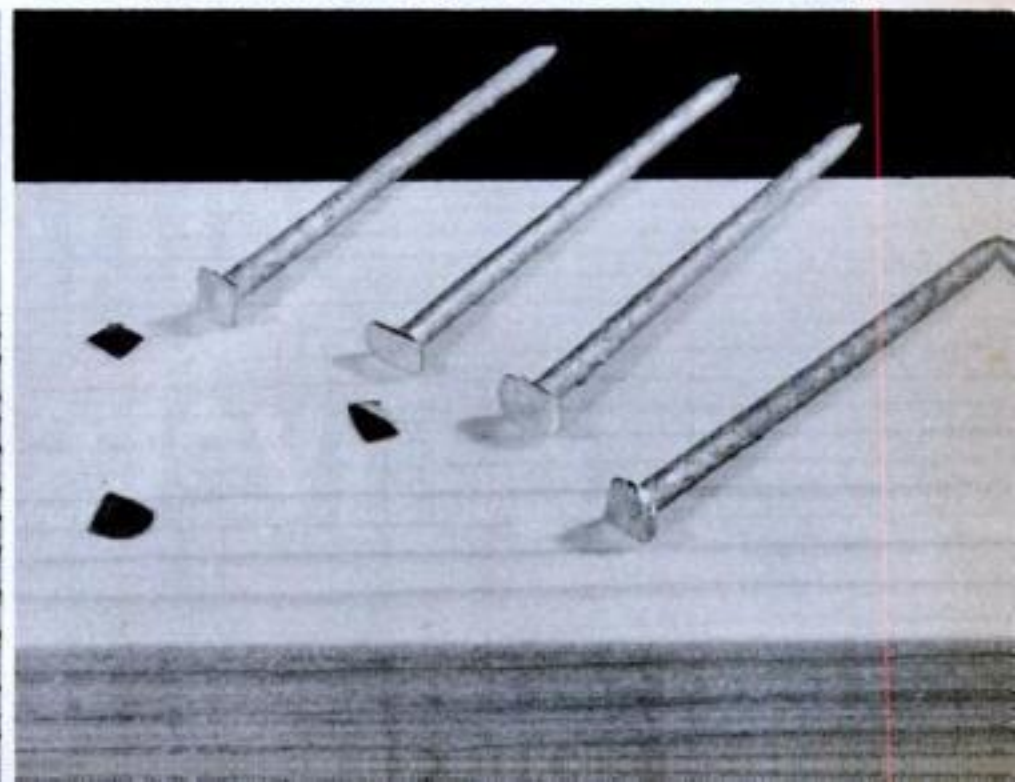
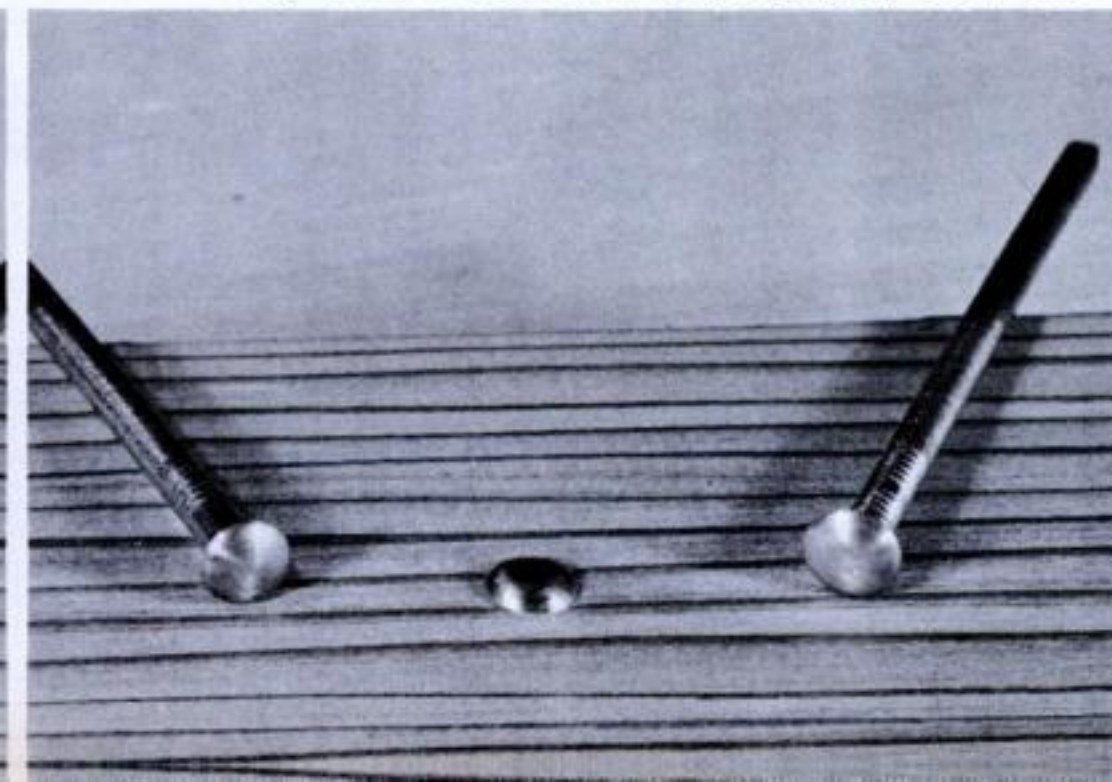
NEED HANGERS, especially for use in perforated hardboard? Start with finishing nails of various sizes and bend to any shape you want.

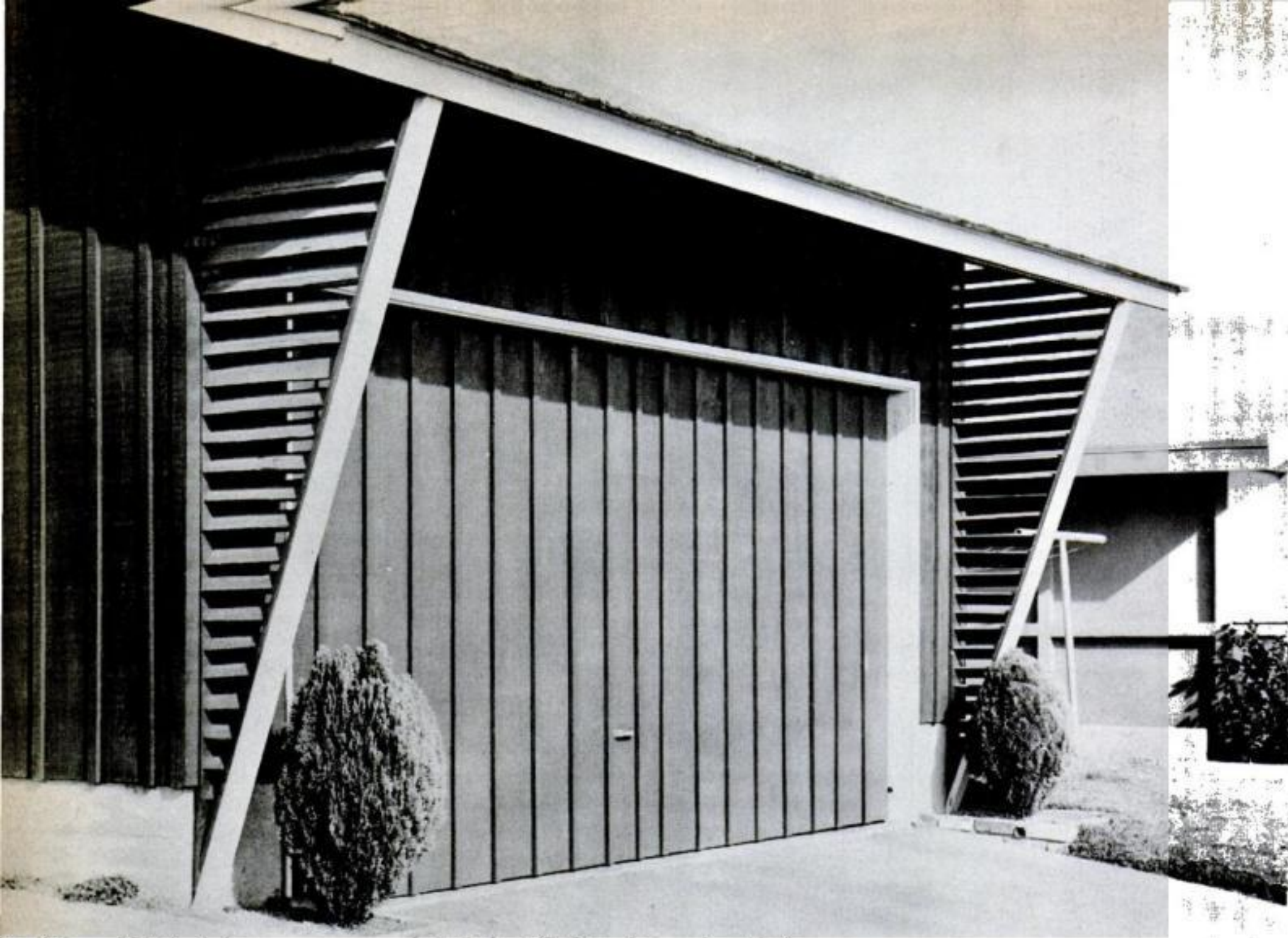
USE 'EM DECORATIVELY: A nailhead can be made to look like a rivet. Shape head with a file; sand smooth and bright; apply clear lac-



SPECIAL HARDWARE? You can flatten nails easily by hammering them on a steel block. Shape into old-style hooks or other hardware.

quer to keep the luster. Heads of common or box nails can be given decorative shapes (photo below). Smooth and polish them by sanding.





POPULAR SCIENCE *90th* YEAR SPECIAL

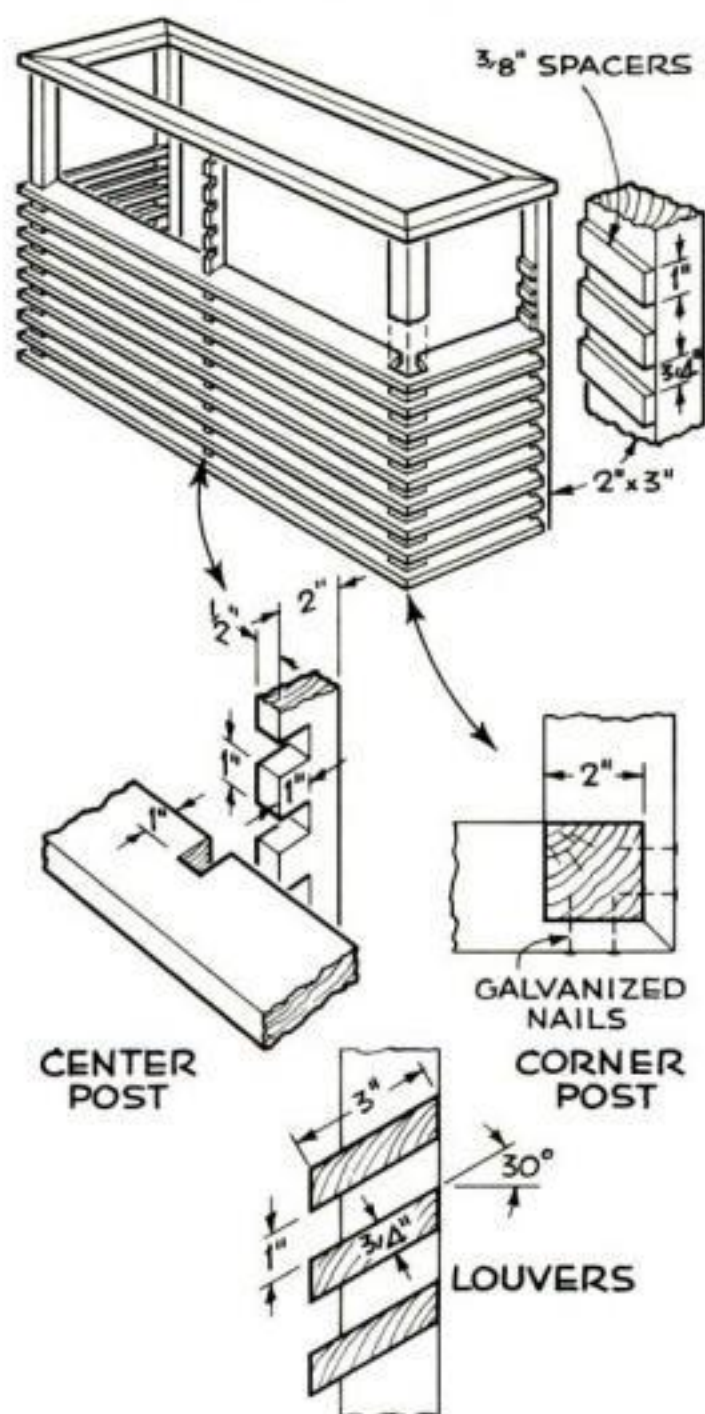
How to give a house **The Smart Look with Louvers**

LOUVERS can be an asset to your house. Their pleasing lines soften a harsh exterior, dress up a plain one, make a small house look bigger. Note how they add an attractive appearance to a normally boxy garage above, at the same time serving as functional supports for the wide roof overhang.

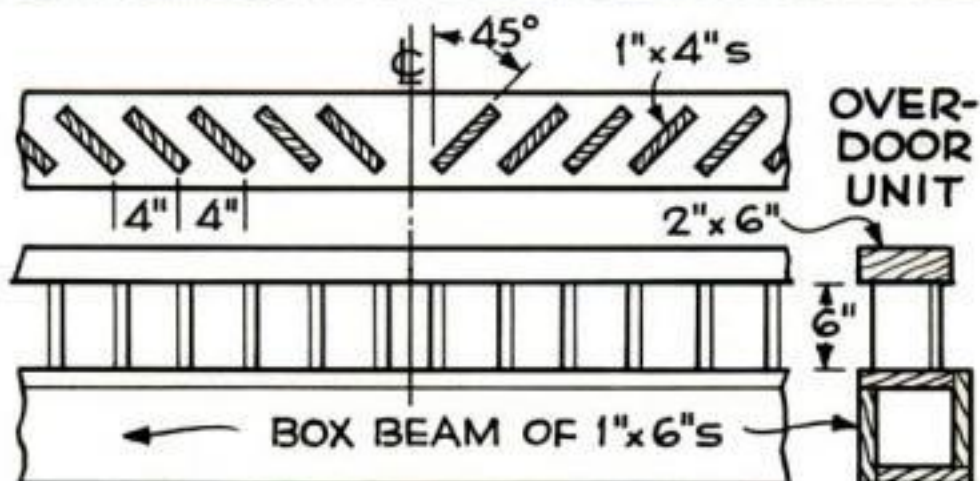
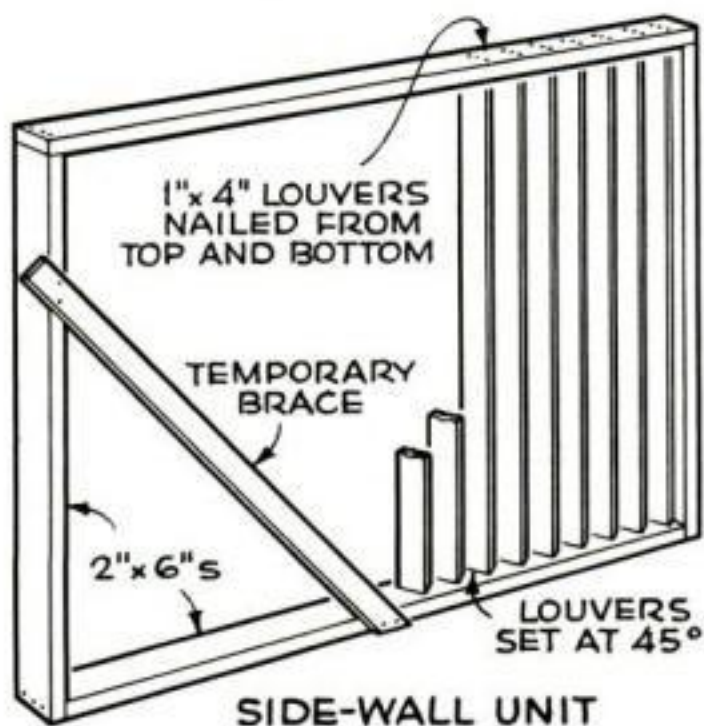
Louvers aren't hard to make. They're just a simple principle, repeated many times. The old, fussy technique of grooving the frame to hold the louvers is often eliminated nowadays by timesaving tricks. You can build up grooves by tacking spacer blocks to the frame. Or you can simply nail the slats in place through the outside of the frame.

Louvers have a special ability to provide privacy without blocking valuable ventilation. Today's use of wider slats is the secret of giving these old-time devices a fresh, modern look.

Exterior louvers are functional, too—for ventilation and privacy

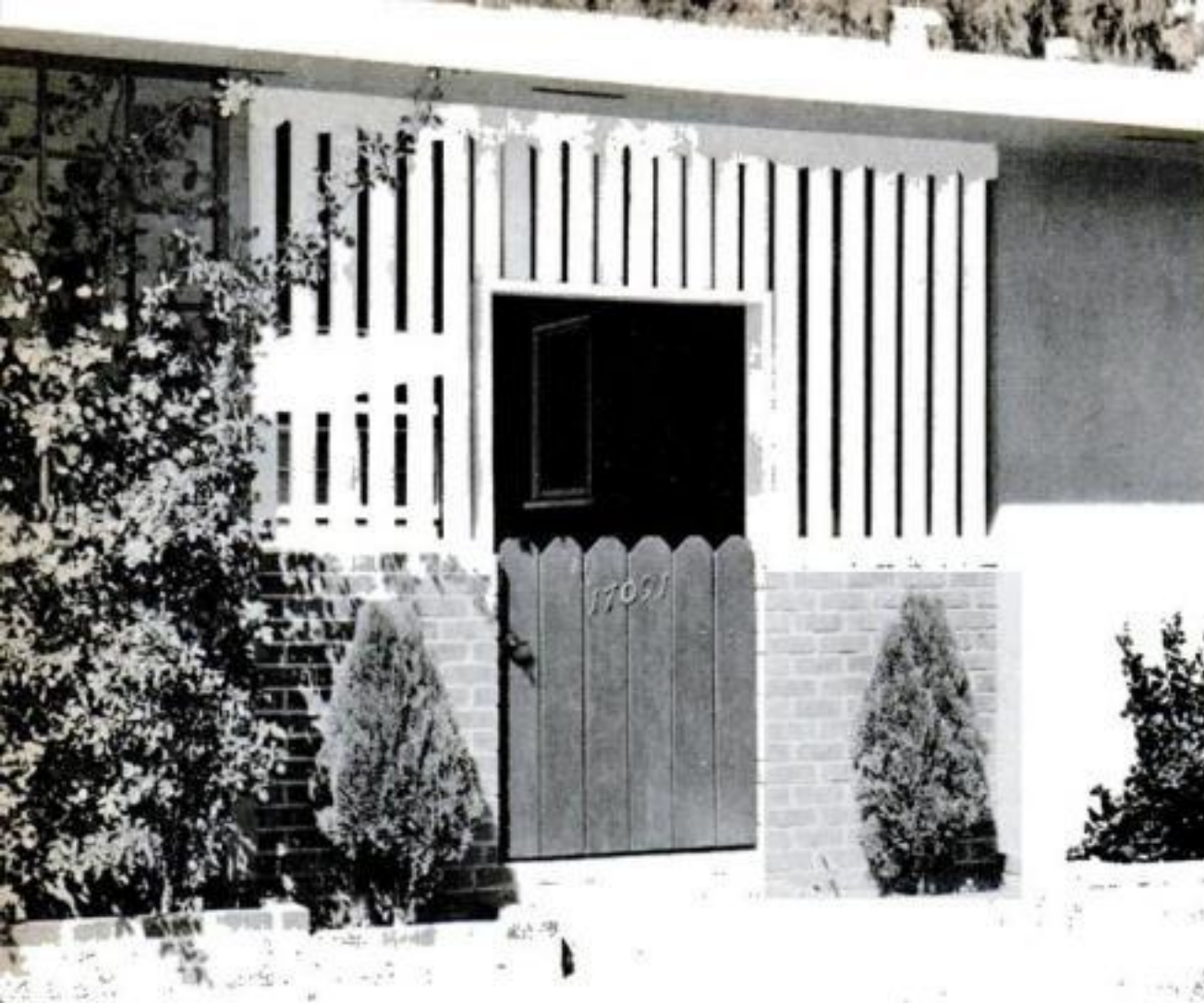


THREE-SIDED STRUCTURE has many functions at the side of this one-story house: It supports a wide projection of roof over patio and increases privacy, screening the patio from the front lawn. Foundation is a brick planter; delicate flowers, within niche on other side, are sheltered from rough weather. Compound miters are best cut on a bench saw, with the work resting on a 30-degree wedge.



LOUVERED CARPORT WALLS give lighter appearance and more interesting texture than siding, yet offer shade, even when the sun is low. Short louvers over open ends reduce pocket of warm air under roof. Side frames are assembled on ground and lifted onto foundation walls. **CONTINUED**



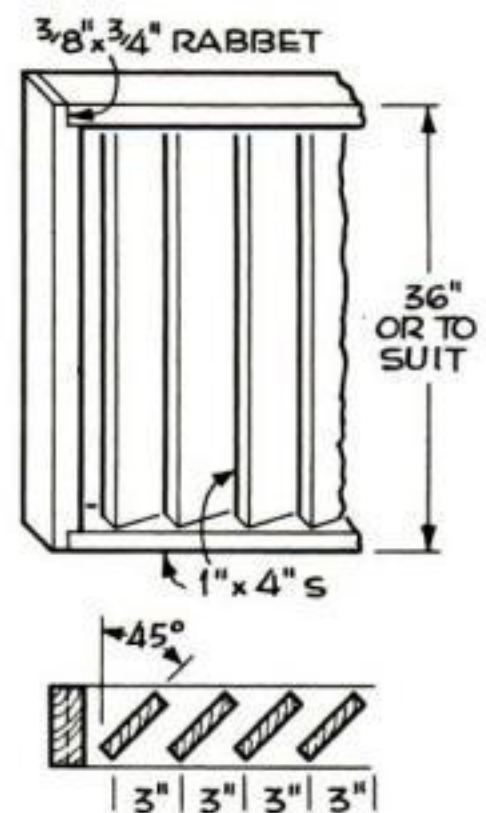


AN ORDINARY GATE becomes a dramatic entryway when you erect a louvered frame on sills anchored to the top of the wall. Breezeway-type roof extension permits spiking top of frame to soffit, finishing off with scalloped valance. But this type of privacy screen could be built around any gateway between buildings—without choking off welcome breezes.



LONG, DECORATIVE PANEL, suspended above shrubs, forms a privacy "wall" for this shed-type carport. The entire construction is of one-

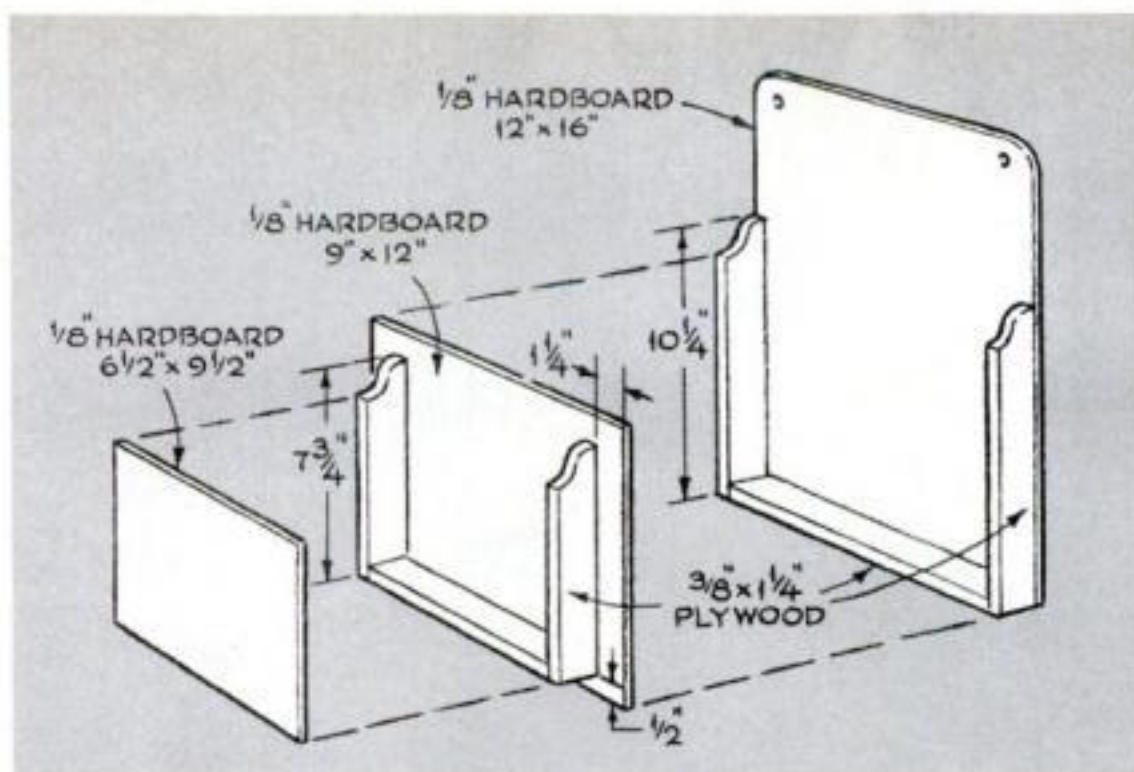
by-fours, painted to match existing structure. For a neater, stronger frame, the top and bottom rails should be set into rabbets.



BEFORE AND AFTER VIEWS show how a single-walled carport, projected from the end of boxy home, adds architectural distinction while serv-

ing as an awning for the windows and side door. By making it extra wide, the builder also provided a sheltered concrete-slab porch. ■ ■

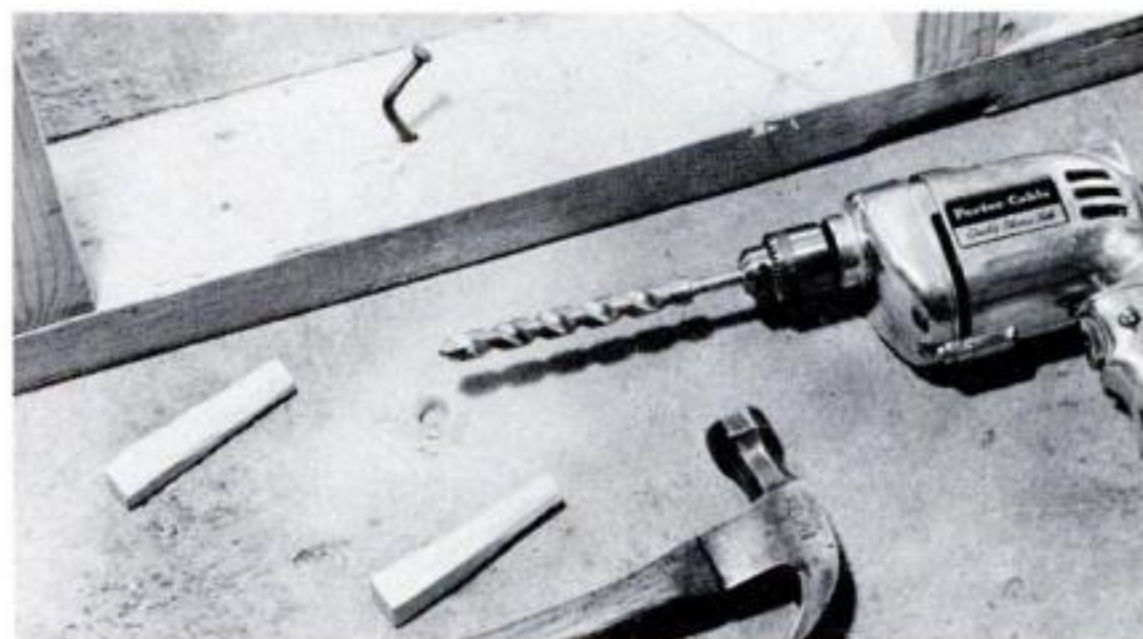
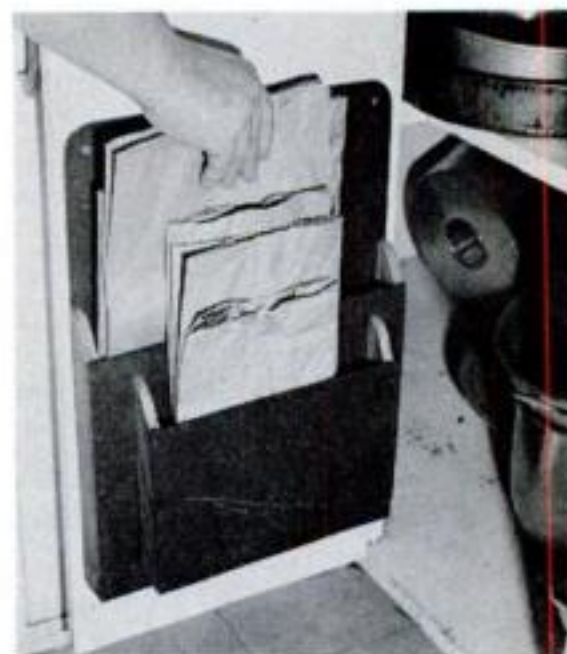




Neat storage for grocery bags is provided by this double pocket hung inside a cupboard door. It sorts the folded sacks into two sizes for quick selection. If space permits, you could add a compartment for shopping bags. Glue and brad the frame members to the back and partition (as above), and then join the units. The smaller frame is set in from the panel edges for easy assembly.—*Louis Hochman, Sherman Oaks, Calif.*

Home Improvement Tips

FROM PS READERS



Wood plugs in concrete are fine for anchoring a partition sill or floor-mounted fixture. You can spot them accurately by driving spikes until they crumple on striking the concrete. Slide sill or fixture aside and drill holes at the nail marks, using a masonry bit. Tap in tapered plugs and drive in new spikes.—*Jackson Hand, Westport, Conn.*

Trimming 3" fiber-glass batts with a utility knife or saw left a rough cut. So I borrowed a 24" paper cutter from my

office and placed the tar side of the batt down. I got a clean cut every time.—*J. H. Logan, Ottawa, Ont.*



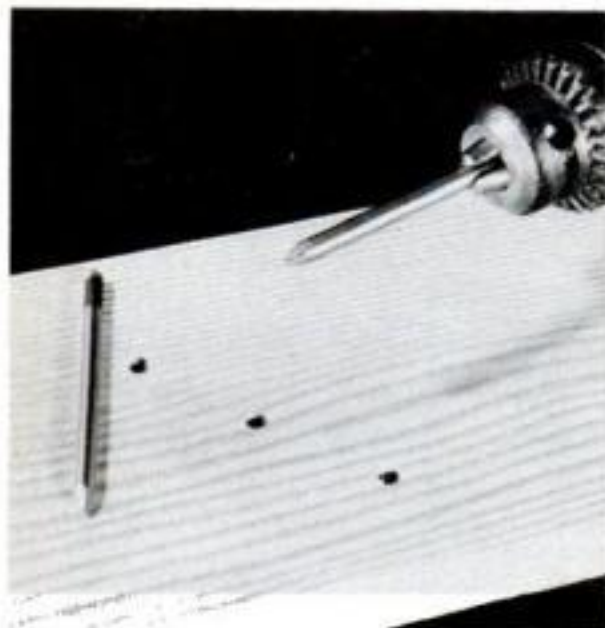
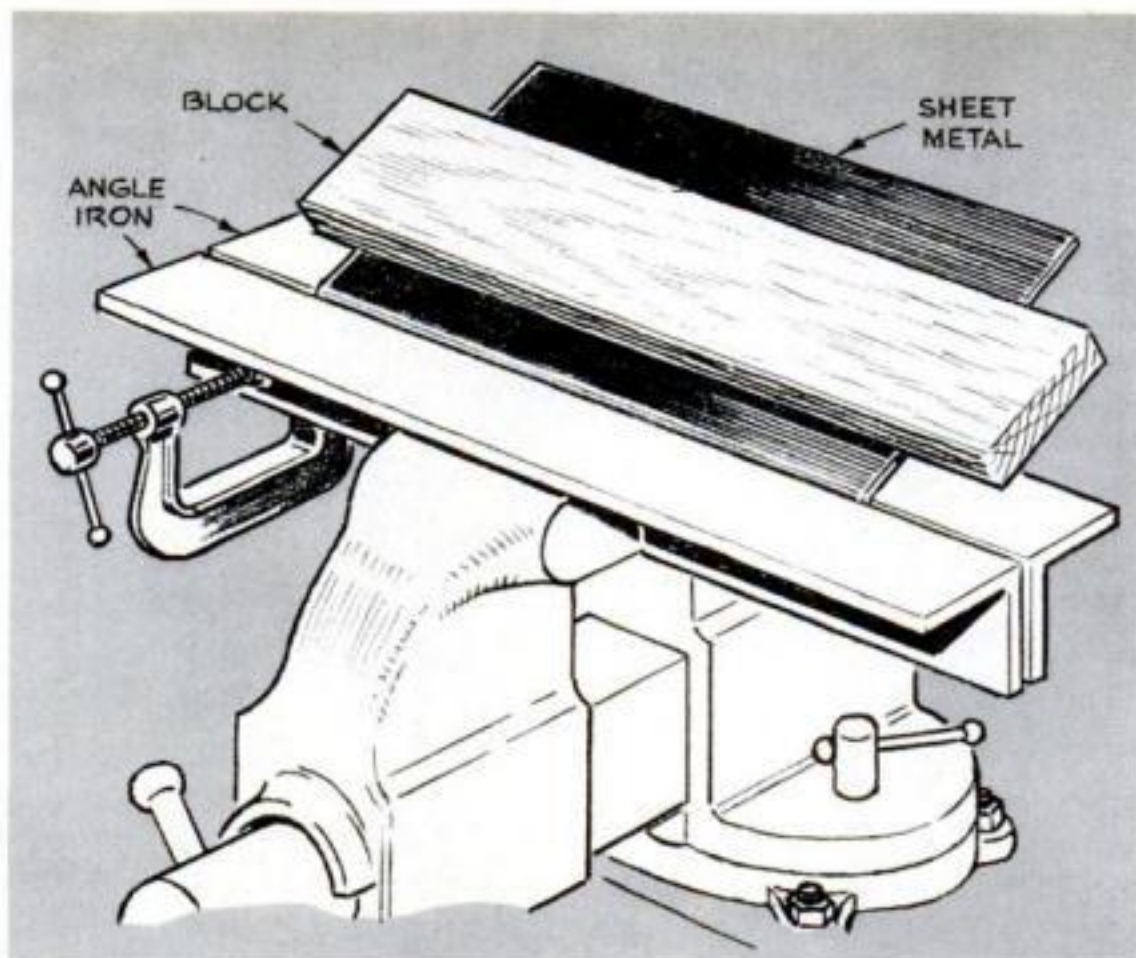
Waterproof splices for underground electrical cable are assured if you encase regular soldered and taped splices in a foot of plastic water pipe. Force roofing cement into both ends with a small stick. Buried, the splice will last as long as the wire.

Pull picture hooks without chipping the plaster: Hook a claw hammer over the nail and strike the head upward with the heel of your hand, as shown. This draws the nail at the angle it was driven, leaving only the original hole to hide with patching plaster.

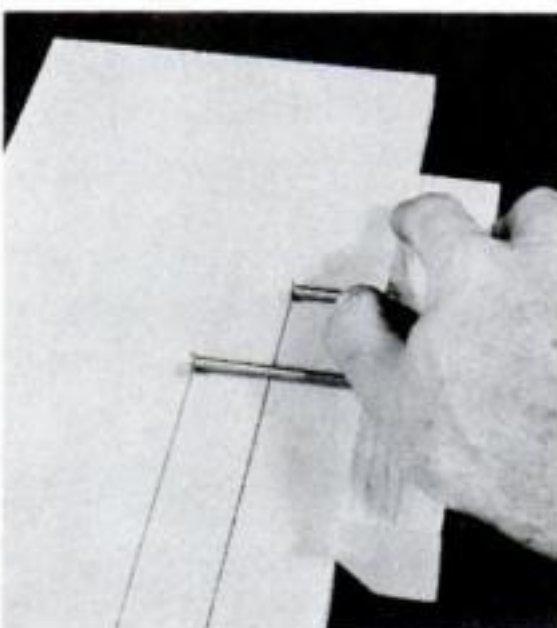


7 Tool Tips for the Home Shop

YOU DON'T NEED A BRAKE to make bends in a large piece of sheet metal. Clamp it between angles in a vise, and bend by pushing against a block at least as long as the sheet metal. If the sheet is so long that the angles tend to separate, fasten them with C clamps at each end.



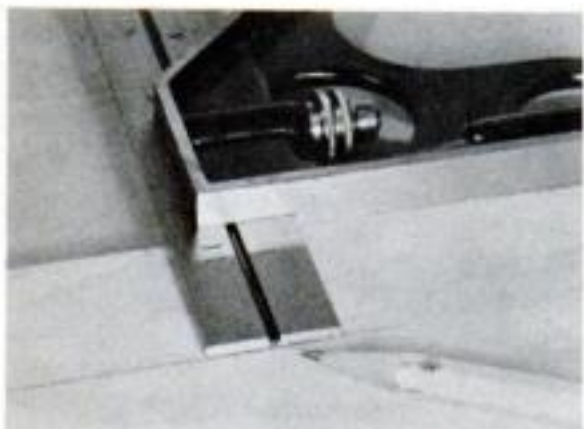
CAN'T FIND A DRILL BIT of the size you need? Choose a nail that size, cut off the head, and chuck it in your drill. It won't lift the chips out, but it will do a drilling job in a pinch.



MULTIPLE MARKING GAUGE can be made by driving nails or screws a specific distance into a wood block. To scratch hard surfaces, you'll have to file nail-heads to a sharp edge.



MINIATURE SCREWDRIVERS can be made from nails. Flatten tip, shape on grinder or sander, harden by heating cherry red and dipping in water. Pointed tool was turned in drill chuck.



NOTCH A COMBINATION SQUARE to improve its performance as a marking gauge. A small V, filed at the center of the end, holds your pencil in place as you slide the square along the edge. It also brings the pencil point in line with the end, for greater accuracy.



TO STORE SMALL WRENCHES or drill bits, try a discarded bowl gasket from a vacuum coffee pot. Insert the shanks in the slit in order of their size graduation. They stand upright for quick selection on the job.



WHEN YOU WANT A GROOVE—on the table saw—wider than a normal kerf but narrower than a dado cut, snip a washer from cardboard or heavy paper. Cut it in two and use half on each side of the blade. The out-of-line blade wobbles enough to make a kerf wider than the blade.

**One man's findings:
The good points
overshadow the bad**

Why I Like Water- Base House Paints



By Bob Gilmore

DREAD the thought of tackling that big house-painting job? Take heart. There's a new paint that's been kicking around for a while, but hasn't been tried by too many people yet. You should know about its good points.

This new paint has a water base just like the interior wall paints that have become so popular. It goes on the *outside* of your house with the same wonderful ease as the others go on inside. You thin it with water, rinse out your brushes with water, wipe up spills with water. There's practically no odor.

Exterior water paints have actually been on the market for several years, but have been slow to catch on. Considering their spectacular advantages, you may

well wonder why. There's a reason. Because the new paints are chemically different from conventional oil and alkyd types, they do not bond well to old paint or to new, bare wood unless the surface is carefully prepared.

There's a big difference between the glowing promises of the sales pitch and the stern warnings you'll find in the fine print on the back of the paint can. You shouldn't be misled. In most cases, proper preparation requires the use of a special primer, one made to go with each particular brand of water paint you buy. Also, the new paints do not yet have the hiding power of the older types. To get good coverage, two coats are recommended, even over a prime coat.

This means, when you use water-base paint for the first time, that you'll prob-

CONTINUED

POPULAR SCIENCE

90th
YEAR SPECIAL



Why many home owners love the new water-thinned paints

PLAIN WATER and a little soap or detergent are all you need to rinse water paints out of a brush or roller. A scrub brush helps loosen any paint that cakes in the heel or ferrule. Spill some, too? The same treatment quickly whisks spatters off the floor, as below.



ably have to resign yourself to a three-coat job, or at the very least two coats if your old paint is in good enough condition not to require a primer.

The good points. This is a drawback, true, but not as serious as you may think. You do the three-coat job only at the start. Once you've switched to the water-base system, repainting is the same as for any paint.

All in all, water paints offer so many pure delights that a little extra work at the beginning really pays off later. Here's why I think so, after investigating the

Six fresh-paint tips that help speed the job

paints thoroughly and trying them on my own house.

Besides their ease of application, water paints are expected to outlast the old stand-by types dramatically. You won't have to repaint as often. One reason is their tough resilience—they give instead of cracking like other paints. This has already been proved at our house by the paint's ability to withstand the scrapings of the small fry's wagons and bike handlebars for more than a year.

The paints are also relatively inert; once cured, they won't gradually become brittle and chalky the way oil-base paints do as they oxidize with age. The pigments are more stable, so colors stay brighter longer and the whites whiter. The inert surface sheds grime and resists alkalies, fumes, and mildew.

And—get this—where ordinary paints form a solid surface film that traps inside moisture vapor behind it, the new types "breathe," allowing the vapor to escape safely. Under normal conditions, they'll never peel; there's no trapped moisture to build up pressure and cause blisters. Since peeling is probably the biggest single cause of paint failure, this blister resistance is the real loud-shouting feature of the water-base finishes.

There's another. If your house is a combination of several materials—wood, stucco, concrete, or metal—you can pick a single color and coat all parts with the same paint. You'll never have to fuss with matching different kinds of paint.

What water-base paints are. Different brands vary in chemical content, but all are basically a water-base plastic emulsion—acrylic, styrene, or polyvinyl acetate.

Why is a primer a must? Because the water emulsion needs a firm foundation to cling to. On bare wood, the water soaks in fast and is drawn out of the emulsion before it can cure properly. Conventional paint, which chalks and flakes, must also be treated to provide a firm grip.

A few makers have developed special additives that can be mixed with the water paint for direct use over old oil paint—*provided* the old surface is in sound



1. YOUR WIFE'S OLD NYLONS make perfect paint strainers. Straining is important if the paint (any type) has stood partially used in a can, or even when new if you plan to spray.



2. HANDY MESS-SAVER: A plastic household pail is ideal for mixing water-base paints when disposable paper pails or other containers aren't available. It will rinse out easily.



3. TRYING TO MAKE PUTTY STICK in a large chip-out before you paint? Drive a couple of tacks part way into the depression. The heads will form an anchor to hold the filler in place.



4. PAINT STRETCHES THIN on sharp corners and will soon wear off. To avoid this, slightly round off corners on moldings and sash edges with a fine sanding block, as above.

5. PROPER WAY TO SCRAPE A BRUSH is against inside of can instead of on rim. It's less messy, easier on the bristles, and leaves more paint on so you don't have to dip as often.

6. TRY THIS TRICK on a wire or buffing wheel to recondition a cleaned roller. The spinning action reffuffs the nap better than any other way. Stand to one side to avoid a shower.



condition. In some cases, the required primer can be mixed into the water paint to eliminate the need for a separate prime coat, but again *only* if the old paint is sound.

Many makers are frank to admit that an old paint job that's still sound is, in reality, a very rare bird. If it's that good, they point out, why repaint in the first place? This is why, if your house needs repainting at all, you'll probably need that initial three-coat job.

Why the paint is fun to apply. It dries so fast—20 minutes on a warm, dry day—that dust and insects don't have a chance to settle on it and stick, the way they often mess up a regular job. Once the paint has set, no sudden cloudburst can faze it. You can even apply it on surfaces still damp from rain; it will stick as tightly as ever.

Laid on with a brush, it has a smooth, effortless slip that's free of the sticky pull of oil paints. Brush marks level out to almost nothing in the velvety flat of its dried surface.

Rollers put it on swiftly, leaving only a slight trace of texture, just as they do on any paint. Where you have to lap a "leave-off" that's hours or even days old, not a trace of difference shows after drying; same with brushing.

In many cases you'll use the paint just as it comes from the can. Except for spraying, it seldom needs much thinning. Because it goes on so easily, there's actually some danger that you may spread it out too thin without realizing it. It's important to flow it on generously and avoid overbrushing. Average coverage should not exceed 450 square feet per gallon.

These paints aren't miracle workers. The surface must be just as smooth and clean as for any paint. If your old paint is peeling, the new stuff won't stop it. All blisters must be scraped down to a solid surface.

Be sure to read the label on the make you buy—and heed its instructions. Different makers recommend different application procedures. Special undercoaters are also generally required if you plan to put the paint on metal or masonry.

My own favorite way of applying water paint is with a spray gun. Because it dries so fast, you treat it exactly as you would a lacquer. You thin it carefully first, then use a gun with pressure feed and an external-mix nozzle.

You can rent a spray rig for a few dollars a day and, in my opinion, it's well worth it. If you can, get the two-hose type shown on the first page of this article. It feeds from a large remote paint reservoir instead of a small cup on the gun. This saves you running up and down the ladder for frequent refills. The proper attire, as you can see, includes a paper-bag hat, neck cloth, respirator mask, and old, old clothes. A handy aid to carry in your hip pocket is an old toothbrush for whisking paint buildups off the gun's nozzle.

Regardless of the method you use, there's one big compensation to that three-coat requirement. The paint dries so fast that you can start a second coat within as little as two hours. On hard-to-reach places, this means you need set up ladders and scaffolds only once and can leave them there until the job is done—the same day. For my money, that's real magic. ■ ■

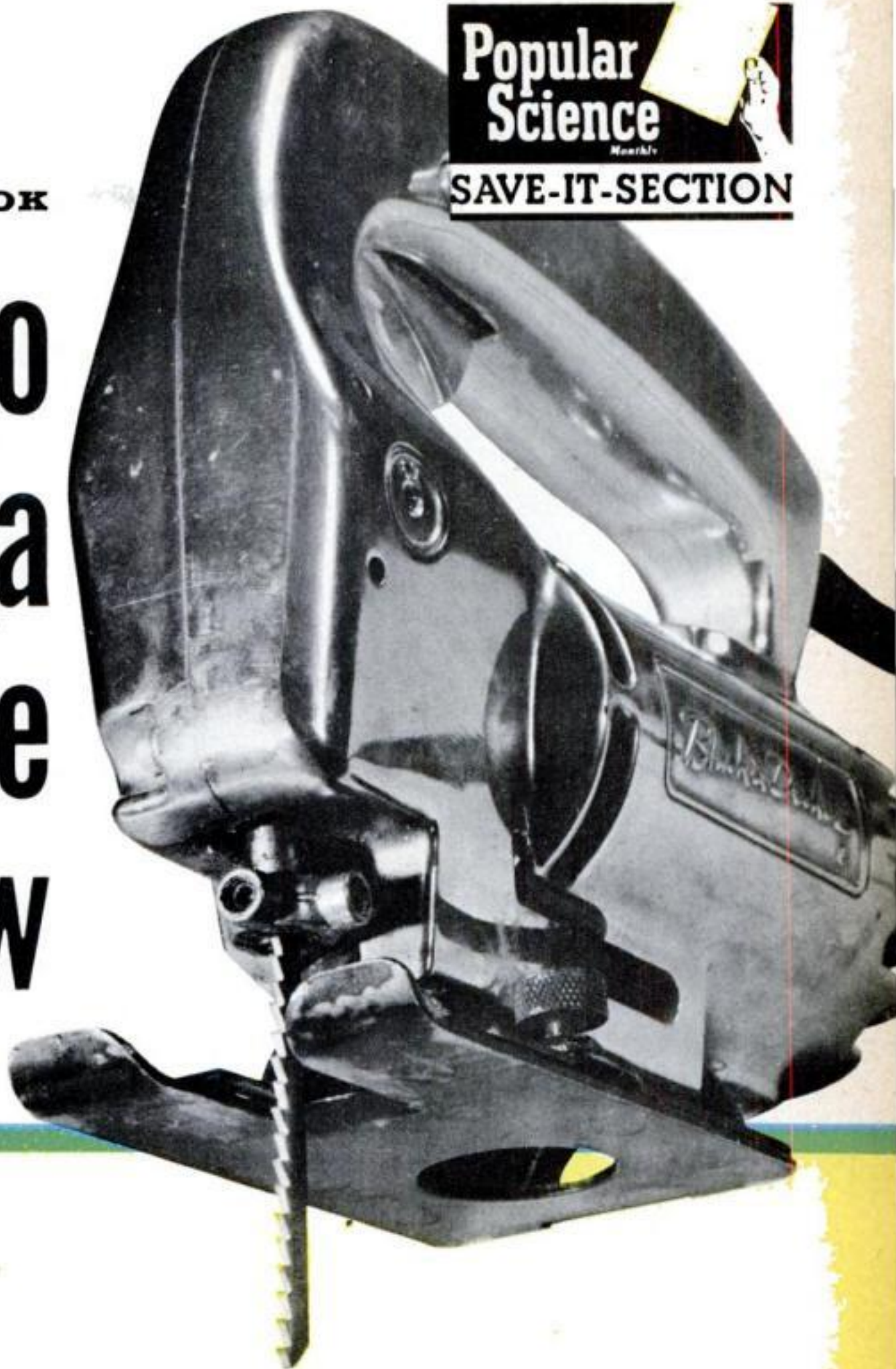


To remove this SAVE-IT SECTION...

... Pinch the eight pages together and lift firmly, tearing them free first from one staple and then the other. When the section is free from the magazine, staple it along the back fold and crease a strip of tape over the spots torn out by the staples.

FROM A NEW BOOK

How to Use a Portable Jigsaw



*Condensed from
a Black & Decker
handbook:
"How to Choose
and Use Power Tools"
by Harry Walton
(Popular Library,
New York).
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by Black & Decker.*

By Harry Walton

WITH just a bit of practice you can pick up the jigsaw as casually as you would a pencil, and accurately follow irregular lines by eye. This ability to do freehand scrollwork is one of the machine's great advantages.

But it is far from all. To enjoy all of the jigsaw's versatility, you should use it for such jobs as fitting pieces to irregular contours, ripping stock to a straight line, crosscutting at odd angles, and notching two-by-fours. You should be able to make quick use of mechanical guides, the radius-cutting attachment, and the special blades available for sawing metal, cutting cardboard, and trimming floor tile. Here are pointers on getting the most out of this fascinating power tool.

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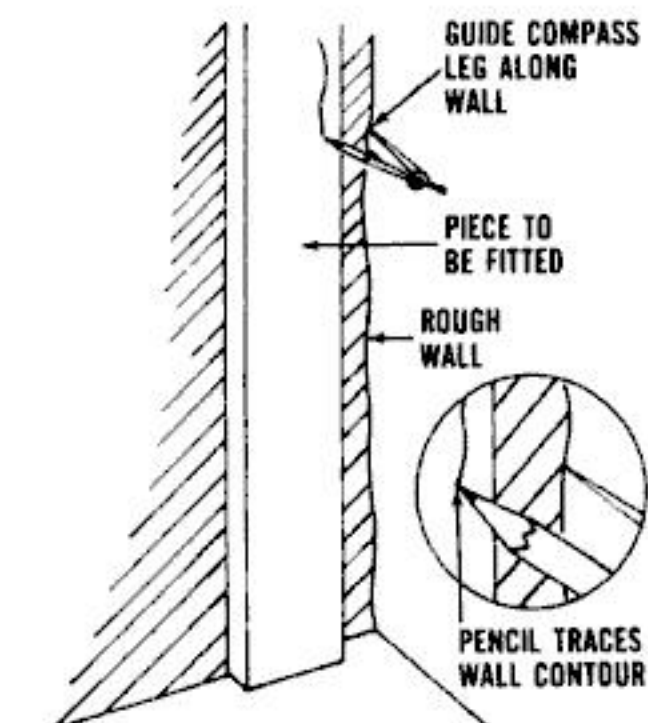


FIG. 1

Ripsawing to width. A coarse-toothed blade can be used for this if smoothness of cut is not essential; otherwise a slower-cutting 10-tooth blade is best. The saber saw is ideal for cutting one edge of an apron, or a soffit or fill piece that must fit closely against a ceiling, a wall, or any similar not-quite-straight line. Hold the piece to be so fitted firmly alongside the surface it is to match. With an ordinary compass set firmly at any convenient spacing, scribe the cutting line as shown in Figure 1. The pencil line will follow both large and small irregularities. Guide the jigsaw along it by eye.

Want to rip a board to some nonstandard width? If it has a true, straight edge you can use the rip guide. The guide may be inserted from either side of the saw base to put the guiding head on the right or left side, whichever best suits the job in hand. With the power cord disconnected, measure from the side of the blade nearest the straight edge to the edge to set the desired cut-off width. (It is always best, on critical work, to make a trial cut in scrap wood.)

Starting the rip cut requires special care, as only the end of the guide is in contact with the work edge at first. Once the guide head is touching its full length, you can use one hand to hold it in contact. Keep your eyes on the guide rather than on the blade, which will obediently follow where the guide head leads it.

But what if the work has a rough, irregular, or even splintered edge? You can cut that part off along a straight line. If the piece is not too wide, set the rip guide to follow along the other, and presumably straight, edge. If the stock is wide or has no straight edge at all, do it as in Fig. 2.

Tack a straight-edged piece of wood to the upper surface, its edge one half the saw-base width inside the intended cutting line. (Use enough nails to hold this strip firmly all along its length, but sink them only part way, leaving enough protruding to make them easy to pull out.) Remove the rip fence if it's in the saw base. Then guide the jigsaw directly against the wood strip. It's an advantage to have the guide strip longer than the work so that it projects at both ends.

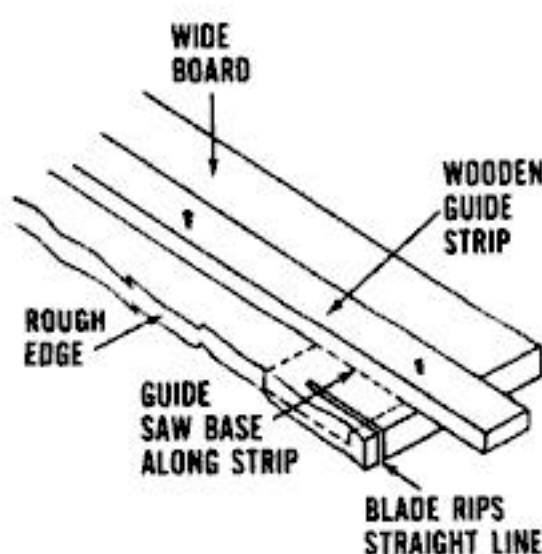


FIG. 2

Crosscuts with the saw are simply a matter of guiding it straight at an angle of 90 degrees to the work edge. You can mark the cut with a try square and carefully follow it by eye, but it is easier and more accurate to use a guide.

One you can buy is a protractor style; it consists of two metal straightedges joined with a pivot, plus a quadrant marked in degrees. The device can be locked at any angle between zero and 90 degrees (Figure 3). In use, the leg underneath is held firmly against the edge of the work farthest from you (with the left hand) and the saw is guided along the long leg. If

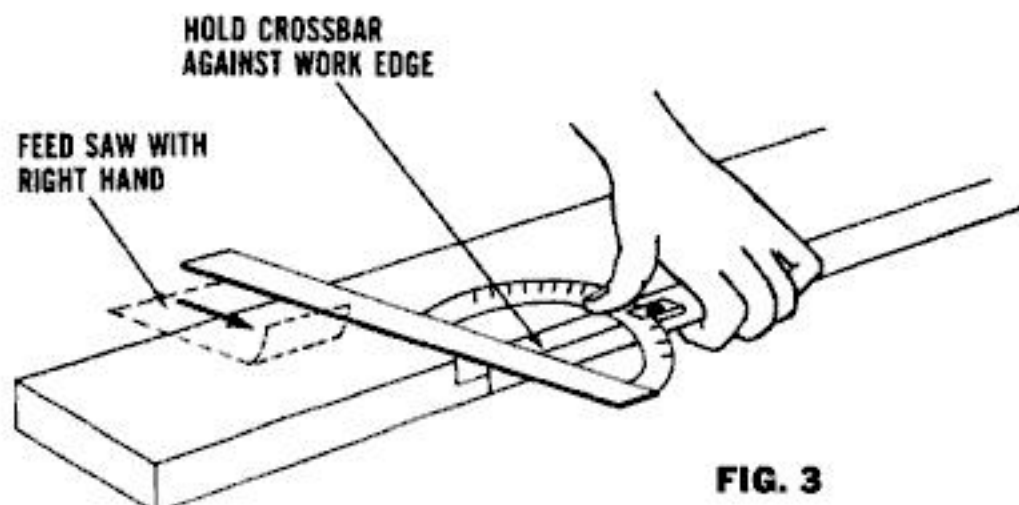


FIG. 3

you hold the protractor against the nearer work edge, you will have to handle the saw with your left hand, which is less convenient for most right-handed persons. Whichever you do, try to hold the guide against the part of the stock that remains supported, not against the cut-off.

A homemade guide is shown in Figure 4. Properly assembled, it will give you accurate 45- and 90-degree cuts (the two angles most commonly used). A large carpenter's square is helpful in making the guide to the necessary degree of accuracy. Corrugated or miter-joint fasteners may be used to join the parts at the apex. Common nails will do for fastening on the crossbars.

Both crossbars must, of course, be fastened at exactly 90 degrees to the long leg and at 45 degrees to the other. The advantage of two crossbars is that you can flip the guide over for making a 45-degree cut that slants the other way, or cut at 90 degrees with the guiding edge at the right or left of the saw as you please. For greater durability, you may want to glue all the joints, fasten them with wood screws instead of nails, and give the finished guide several coats of shellac.

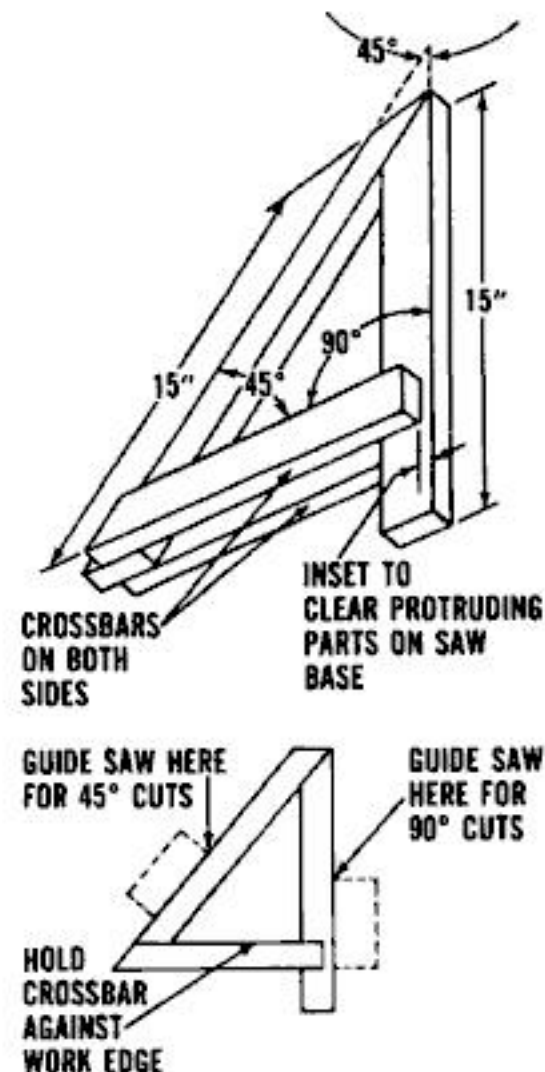


FIG. 4

Bevel sawing. Bevel cuts are those made at an angle to the face of the work, which means the blade has to saw through a greater thickness than at 90 degrees (Figure 5). It will therefore cut more slowly and, because blade thrust is partly toward the horizontal, have more of a tendency to wander sideways than in straight-through cuts.

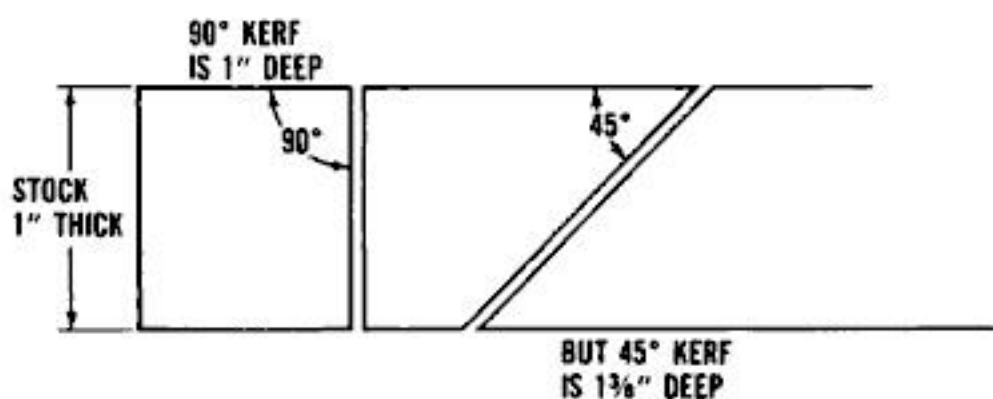


FIG. 5

Some saws have a separate tilt base that must be mounted in place of the standard one. Others have the tilt feature built right in. A good jigsaw will have a graduated quadrant that shows at a glance at what angle the base is tilted. Use two hands for bevel-sawing along a guideline or with a rip guide. Keep the thumb of the left hand behind the guide lock screw or some other base projection well back of the blade for safety (Figure 6). For bevel-sawing across a board (to make a box with mitered joints, for example) it's not a bad idea to tack a guide block fast to the work. Use a try square to set it accurately, and drive the nails in far enough to hold well. Another dodge with handheld guides is to drive a stout nail into the work for the side of the guide to butt against. This prevents the tool from slipping sideways, as it otherwise tends to do, no matter how firmly held. You can also, of course, clamp the guide to the workpiece.

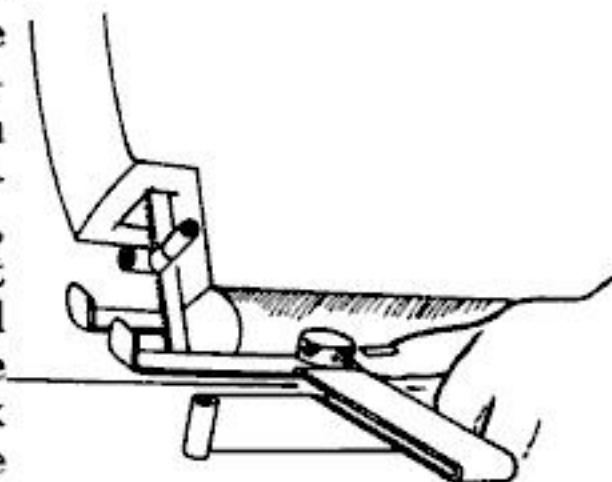
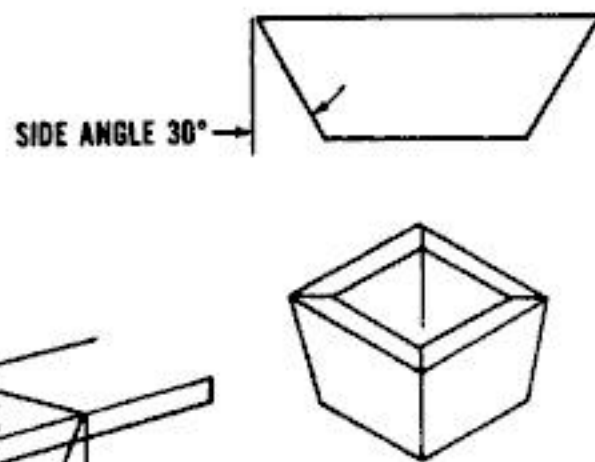


FIG. 6

Bevel cuts must be made slowly; forcing will only aggravate the tendency to wander off the cut. Take pains to keep the saw base absolutely flat on the work surface throughout; if it lifts, the cut won't be true.

The work itself would always be clamped tightly to some supporting surface, the cut overhanging the edge. However, angle cuts are very deceptive because it's hard to tell where

| FOUR-SIDE MITER ANGLES | | |
|------------------------|-------------|------------|
| SIDE ANGLE | BEVEL ANGLE | FACE ANGLE |
| 10° | 44¼° | 80¼° |
| 15° | 43¼° | 75½° |
| 20° | 41¾° | 71¼° |
| 30° | 37¾° | 63½° |



EXAMPLE
FOR
30° SIDE
ANGLE

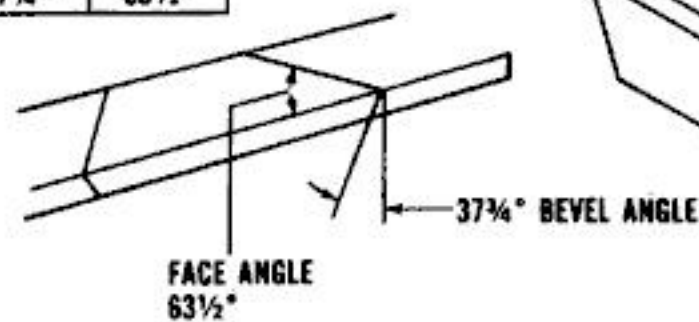


FIG. 7

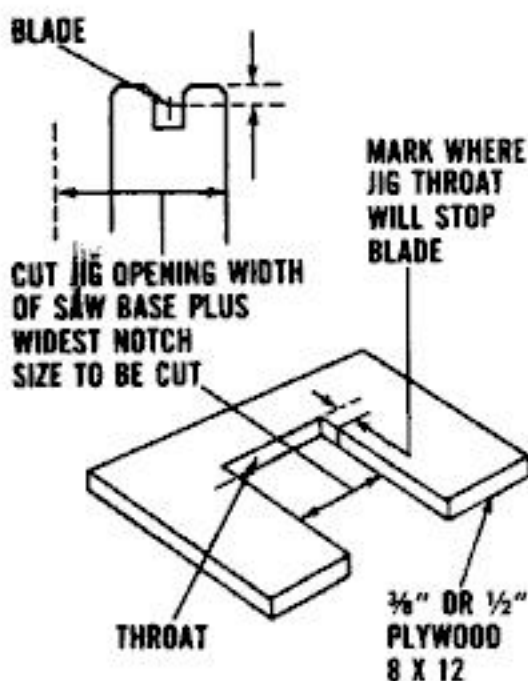


FIG. 8

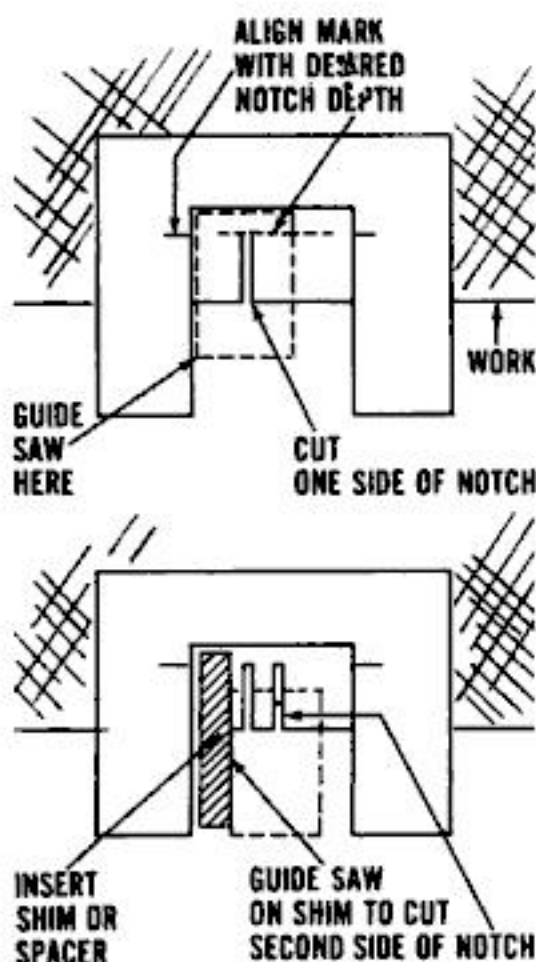


FIG. 9

the bottom of the blade will be traveling. Therefore, take pains to check that it won't run into the edge of the support, or against any of the clamps.

Cutting compound angles.

These are the most difficult of all, as they are made at some angle other than 90 degrees both across and through the thickness of the work. Corner joints made this way are

often called hopper joints, being traditionally used to build funnel-like hoppers, or boxes with sloping sides. They are also useful for making deep picture frames. Both angles must be precise; the settings are difficult to arrive at by trial and error. Here, your best ally is a saw protractor whose adjustable straightedge serves as a guide for the saw shoe. A partial chart of compound-angle settings is given in Figure 7.

Once the angles are determined, the actual sawing is not much harder than that of an ordinary bevel cut. But since accuracy is at a premium, guides should be fastened rather than handheld, if possible.

Notching joint members. In marking out notches to receive another part, use a try square and a sharp, hard pencil. (Thick pencil lines are inaccurate.) Ordinary lumber varies so much in thickness that the piece to fit into the notch should be used to lay out the width of the opening. Experts try to leave a visible trace of the marked line on the work when cutting along it. With care, notches can be sawed freehand to the marked lines. A crosscut guide, however, relieves you of considering angular accuracy and leaves only the problem of sawing the notch the right size.

Figure 8 shows a simple jig which, once made, can be used repeatedly for many sizes and depths of notches. It is a broad U shape of plywood. Use a guide, if only a tacked-on piece of wood, to insure sawing the sides of the wide opening straight, parallel, and at 90 degrees to the throat. Make this opening as much wider than your saw base as the widest notches you are likely to cut. Draw a line across the two legs at a distance from the throat equal to that from the front of your saw base to the blade teeth.

To use this notching guide, or jig, clamp it to the workpiece with the marked line at the bottom of the desired notch depth, and the jigsaw blade (with the base against one inner edge of the jig) aligned to saw one side of the notch. (This blade location may also be marked on the throat for convenience.) Now run the blade in until the saw base is stopped by the jig throat (Figure 9).

Next, the saw must be moved over to cut the other wall of the notch. Do this by interposing a piece of stock of appropriate thickness between the same edge of the jig and the saw base. You can't use a piece of the stock you intend to fit into the notch; if you do, the notch will be cut too

wide. The shim, or piece interposed, must be narrower by the width of the kerf the saw blade cuts.

The shim is best selected by making trial cuts in scrap stock. Once checked out this way, several shims may be saved along with the jig and marked with the width of notch they produce.

When notching two parts that must match exactly—legs for light shelving, for example—it's well to nail them together temporarily and so notch both at once. This insures identical notch-spacing and width.

Turning corners. Having sawed along the outside of the desired notch, you can remove the waste between by any of three methods. These apply in part to any corner at which the blade must change course sharply. The first is to leave the notching jig in position and simply run the saw, free-hand, several times inside the critical boundary cuts you've already made. The throat of the jig will stop the blade at the proper depth. If enough kerfs are cut this way, the little waste remaining will usually crumble out. Any remaining stubs can be removed by shifting the jigsaw along them.

The second method is to mark the notch depth, remove the jig, and with the saw in either boundary kerf gently turn it into the end cut, starting about $\frac{3}{8}$ " from the end of the kerf (Figure 10). Saw along the end or bottom of the notch to the other boundary kerf. Then reverse the saw to cut out the little curved piece remaining.

A third method is to "nibble" out a turning space. Run the saw into one boundary kerf, but $\frac{1}{4}$ " from its end turn the blade slightly into the waste and feed to proper depth. Back up again, turning a little more, and again feed in. Repeat this several times until you have a triangular hole in which you can turn the blade at right angles. Then saw across to the other kerf.

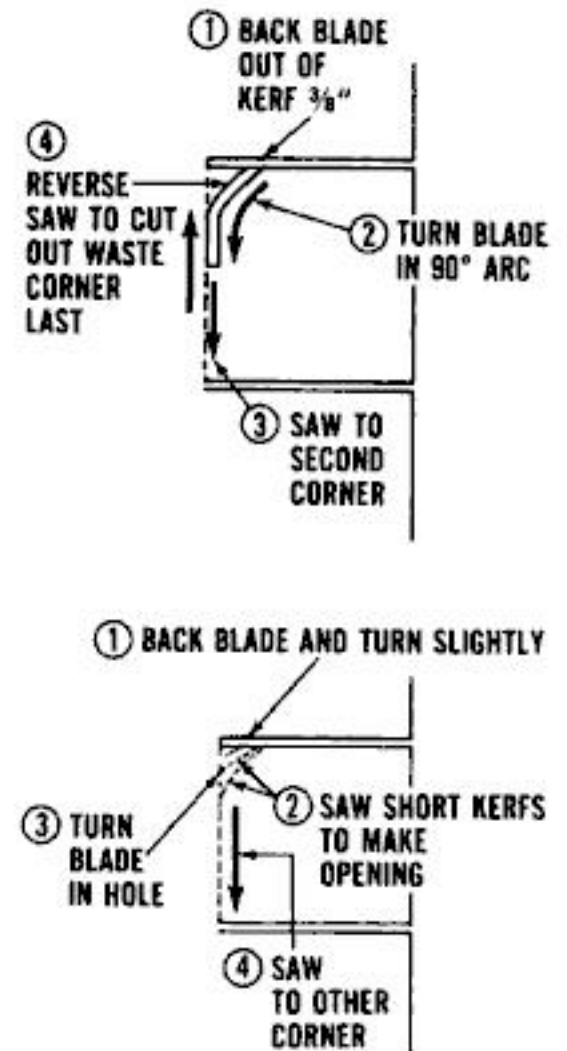


FIG. 10

Cutting circles. True rounds, such as wooden wheels and table tops, can be sawed to almost any size with a circle-cutting attachment. The one provided with the saw is a bar that slides into a socket on the jigsaw base and can be locked at the desired radius. The head of this bar has a hole in which a nail can be inserted as a pivot. With this driven at the center of the desired circle cut, the saw will track around back to its starting point.

To saw a round opening wholly inside a piece of stock such as a plywood panel, first drill a $\frac{5}{16}$ " starting hole, or make a plunge cut as described farther on, well inside the cutting circle. Run the saw carefully out to the cutting line, stopping with the blade aligned with it (that is, at right angles to a radius). Attach the circle-cutting guide and lock it at the proper radius. If this is done with a rule, measure from the blade to the pivot hole in the guide, and be sure to take the width of the kerf into account.

With the blade in the starting hole or kerf, drive as heavy a nail as will fit the pivot hole into the center of the cutting circle. Then feed the saw clockwise until the cut meets.

To make a wheel, you would drill the starting hole outside the circle. Sometimes you may want both a round hole and a clean, unmarred disk; in other words, neither piece

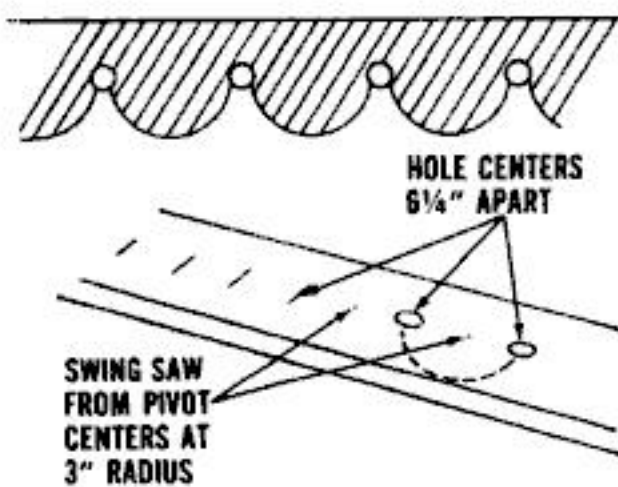


FIG. 11

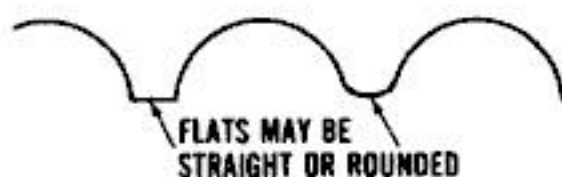


FIG. 12

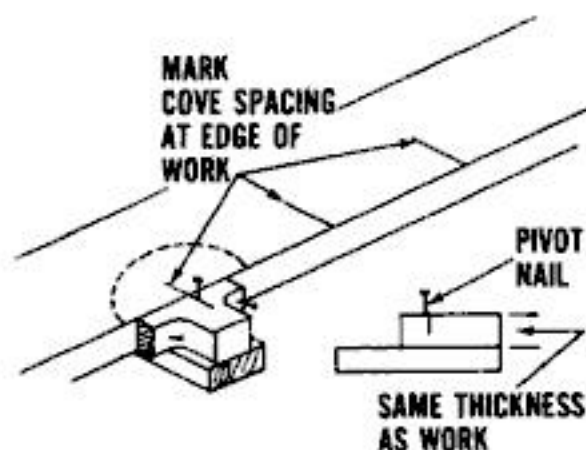


FIG. 13

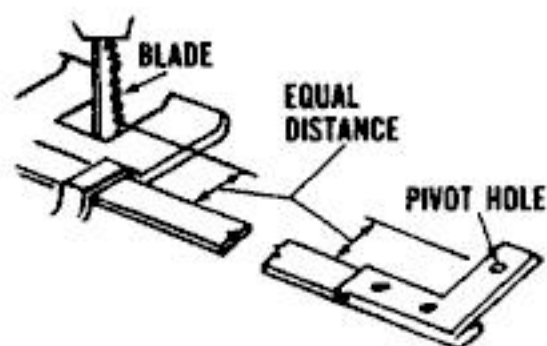


FIG. 14

is to be wasted. With a carefully made plunge cut, which makes a hole no bigger than the blade, you can do this.

Cutting ornamental curves. Scallops and coves can be sawed freehand. But the circle-cutting guide makes it easy to cut out ornamental soffits, headboards, furniture and cabinet aprons, and so forth. A combination of bored holes and sawed arcs becomes interesting and not at all difficult.

Figure 11 shows such a design. Along a line parallel to the edge of a board, intervals of $6\frac{1}{4}$ " are laid out with center marks between them. Holes 1" in diameter are bored at the $6\frac{1}{4}$ " spacings. Then the circle-cutting guide is set at 3" radius, and the pivot nail driven into the center mark between two holes (the saw blade being inserted in the one at the right of the pivot). Swung around, it neatly cuts the 3" radius, leaving a small neck at the bottom of the 1" holes as part of the design. If sawing is done from the back, the pivot holes won't show.

The use of bored holes as part of scrollwork is worth remembering, for the circle-cutting guide will not work below $2\frac{1}{2}$ " radius. Freehand sawing of smaller holes is not only awkward, but rarely produces a truly round opening. Bored holes are truly circular, form convenient starting openings for the saw blade, and are quickly made with wood bits or hole saws.

Another kind of scalloped edge with cove cuts requires pivot points outside the workpiece, as shown in Figure 12. The arcs may meet to form points, or may have short or long straight intervals between them. These intervals may also be rounded off. It's a good idea to experiment with pencil and compass on paper to decide what design and proportions best suit you. This will also show how much outside the work edge the pivot points must lie, and how far apart the radius cuts have to be made.

Mark this pivot spacing carefully on the work edge as in Figure 13. Nail two pieces of scrap stock together as shown. Draw a center line at right angles to the inner edge of the top piece, and spot the pivot center on this line as far from the inner edge as you want it from the work edge.

Align the center line with each spacing mark on the work in turn, drive the two nails into the work edge far enough to hold, and with the circle-cutting guide set at the correct radius swing each cut into the work from left to right. Take special care to hold up the saw near the end of each cut, for you are sawing away its support. Loosen the pivot block and tack it on at the next place. If you cut the head off the pivot nail, the saw can be lifted off and set aside while you're changing the block.

Sawing king-size circles. You may sometimes want to saw a big disk for such things as a coffee-table or garden-table top. The standard circle-cutting guide is limited in radius, but you can improvise a longer one in several ways. If you can get a strip of metal that closely fits the guide slots in the saw base, make the one in Figure 14.

The short leg at the outer end is very important, for the pivot must be aligned with the blade as shown, as far ahead of the bar as the blade teeth are. If the pivot is

either ahead or behind the teeth, the blade will not return to its starting place. Make the short leg from a flat mending plate, a right-angled one or similar bit of metal you can bolt or rivet to the end of the strip. Carefully measure out, punch-mark, and drill the pivot hole to fit a common nail.

For a one-time job, a wood strip may serve if bolted to the regular circle-cutting guide. This can be done with the one shown in Figure 15. Use small screws to avoid weakening the guide. Being hardened, it must be spot-annealed for drilling. It's easier to file a metal strip to fit the guide slot and fasten a wood bar with a pivot leg on it.

With such extra-long guides, take care not to twist the guide bar or force the saw off its cutting path by feeding hard, especially when the blade hits knotty sections. With homemade guides especially, it is a good idea to lay out the cutting circle beforehand by swinging a pencil on a cord looped over a nail at the center. This guideline will show if the blade wanders. However, with a properly located pivot point and slow feed, a blade in good condition should track accurately all around.

Plunge or pocket cuts. One of the really startling things a jigsaw can do is to begin its own cut wholly within a piece of material. Carefully mark out the opening to be cut. At any convenient straight portion of the cutting line, hold the saw with the blade just inside it and its base tilted up at the back, far enough to keep the saw from touching the work surface at all when running.

Start the saw and very slowly tilt it back until the blade touches the work. There is some tendency for the saw to skip when it first bites in. A firm hand and very slow in-feed help restrain it. Rather than try to hold the base with your free hand, you might tack a small block to the work for the saw base to butt against, as in Figure 16.

Keep tilting the saw down—without moving it forward—until the blade has cut completely through and the base is seated firmly on the surface. Only then, start feeding the blade forward (first removing any stop blocks, of course).

Sawing metal. With the proper blade, the jigsaw can cut rods, bars, angle and sheet stock of almost any common metal from soft aluminum to steel. The household aluminum widely sold at hardware stores is readily cut for making screens, railings, ornamental brackets, and the like.

Blades for cutting metal must, in general, be finer than those used for wood, and the thinner the metal to be sawed, the finer the teeth should be. A 14-tooth blade is suitable for metal $3/32$ " thick or more. But for thinner stock a 24- or 32-tooth metal-cutting blade should be used.

Figure 17 shows why. If teeth are so large that a single notch can straddle the edge of the metal, sawing can put enough strain on any single tooth to break it off. At least two teeth should ride the edge of the work at all times. This keeps any tooth from hooking into it, and lets the blade cut as it's designed to do. Jumping of a blade in metal usually indicates the need for a finer blade.

When sawing thick metal, lubricate the blade with a candle, or the kind of stick wax sold for easing window-

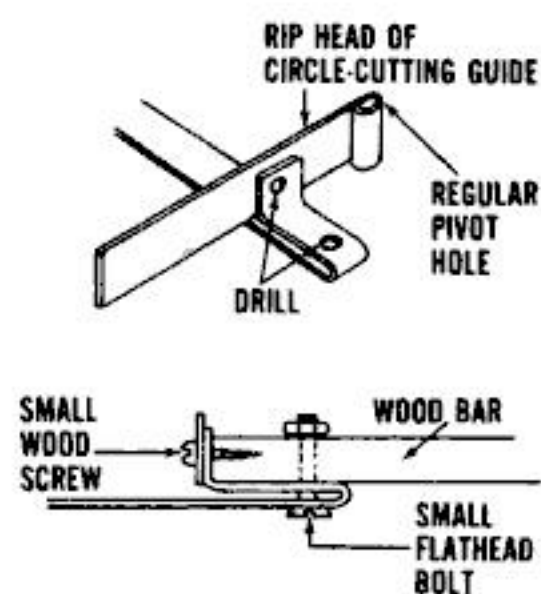


FIG. 15

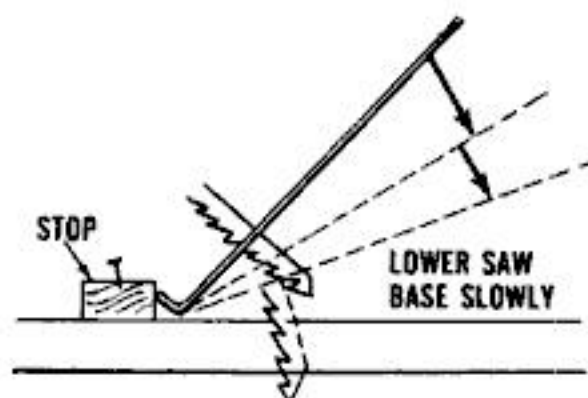


FIG. 16

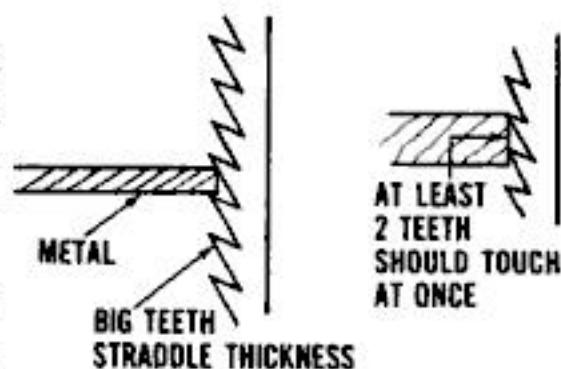


FIG. 17

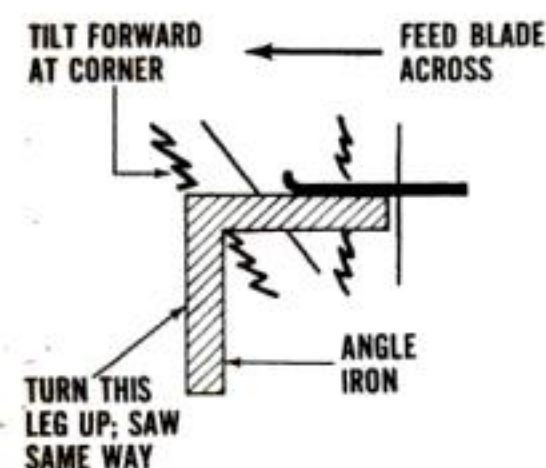


FIG. 18

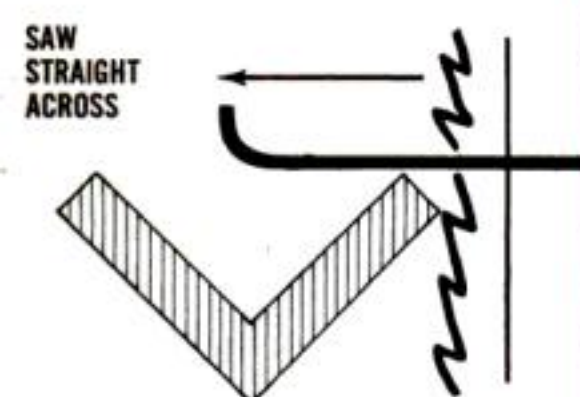


FIG. 19

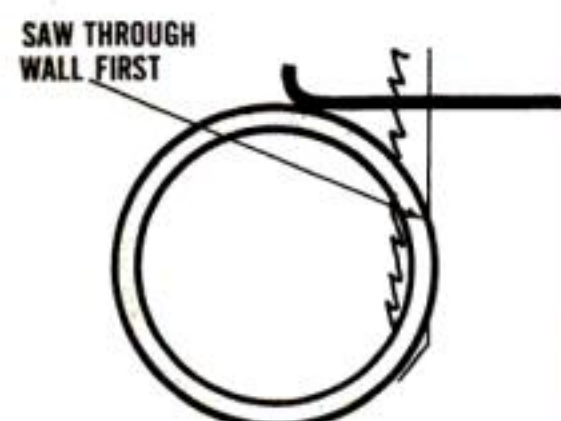


FIG. 20

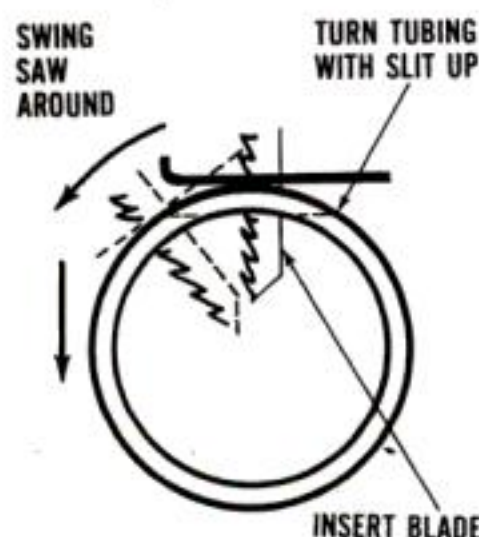


FIG. 21

sash movement. Soft metal may tend to clog the teeth; the next coarser blade may do better, but don't violate the two-tooth rule. Stopping to brush chips out of the teeth occasionally is helpful. Start turns in metal very slowly, for the metal-cutting blade has little set and binds readily. Its harder temper also makes it more prone to break.

Thin sheet metal may bend or even tear when sawed. Use a 32-tooth blade, support the work as close to the cutting line as possible, and feed very slowly. For best results, clamp sheet stock tightly between hard composition board or thin plywood, mark the cutting line on the top, and cut through all three pieces at once. Although extra trouble, this method assures a clean cut on the metal, with no danger of bending or tearing it. It's also a good way to saw two or more thin pieces to identical shape.

Hard going in metal may indicate a worn blade. Should you switch to a new one after starting a cut, restart it from the other edge of the work instead of continuing in the old cut. The reason for this is that the worn blade is sure to saw a narrower kerf than the new one, which will drag, bind, or jump if driven into it.

The fastest way to saw iron angle stock is across one leg at a time (Figure 18). Sawing through the flat of a leg is much slower. Another way to cut small angle stock is across the V section as in Figure 19. Be sure to clamp the material firmly or lock it in a vise. Keep close control of the saw at all times, as there is little support for it.

Even big metal tubing with a diameter greater than blade length can be sawed. Take care that it is firmly held so that it cannot roll against the moving blade. See also that the blade is long enough to pass through the wall on the initial cut without stubbing its end (Figure 20). Hold the tool firmly in the position shown and feed in slowly, as the cut so made is a heavy one. Once the blade has pierced the wall of the tubing, reinsert it on a radial line instead as in Figure 21. Then saw right around the material, constantly tilting the saw base forward to keep it tangent to the tubing at the blade line. The work will probably have to be loosened and reclamped several times.

Cutting soft materials. Plain or corrugated cardboard, soft wallboard, acoustic tile, leather, canvas, rubber, and some kinds of floor tiles can all be cut with the knife blade in the jigsaw. This is a toothless, keen-edged blade that cuts quickly and cleanly. The edge can be resharpened and should be honed to keenness when it shows signs of dulling.

Cardboard can be cut in multiple by stacking it as much as an inch thick and marking cutting lines on the top. It is too soft to clamp without damage, so hold it down firmly on a horizontal surface and make the cut as near the supporting edge as possible.

Cloth, canvas, and soft leather must be backed by cardboard. Fabric may wrinkle under the jigsaw, and like thin sheet metal is best cut as part of a sandwich. Tape it to a piece of cardboard with a second piece on top.

The knife blade makes it easy to cut rubber floor tile to fit around pipes, wall setbacks, and built-in furniture. Asphalt tile can be cut with a metal-cutting blade. ■ ■

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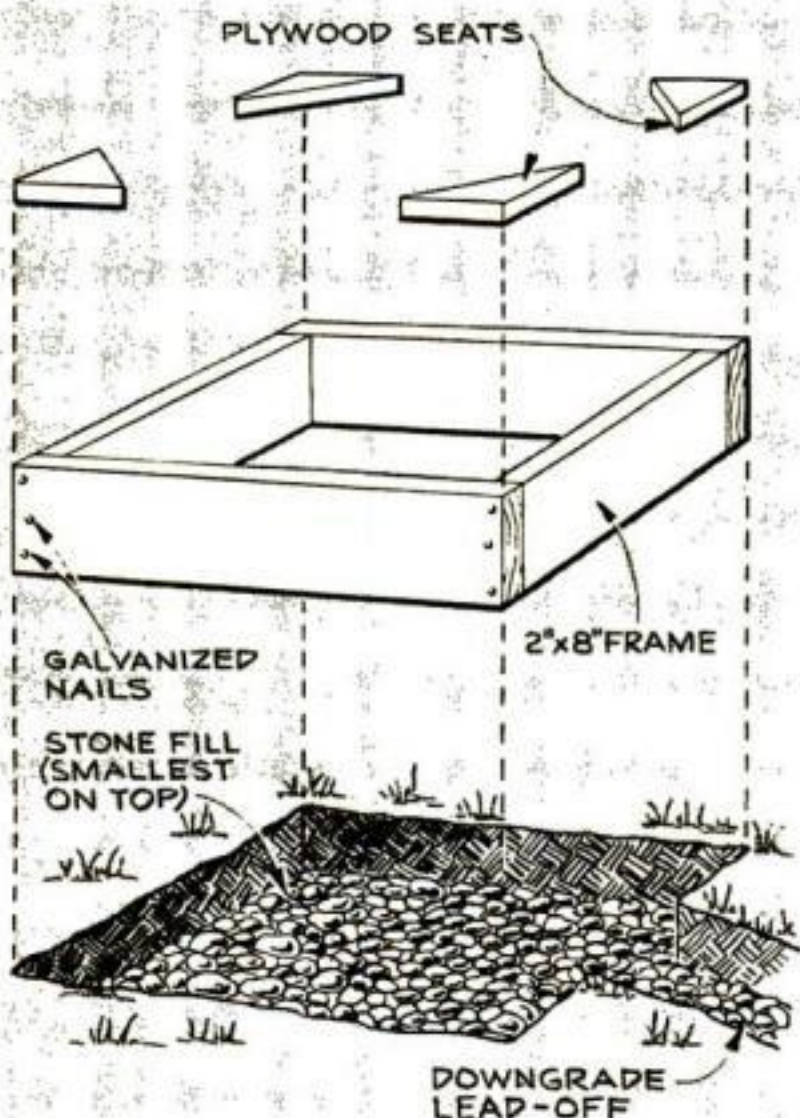
FROM PS READERS

Weatherproof Lid Protects Pickup Load

A SIMPLE framed panel of plywood, blocked up on tapered two-by-eights, roofs over the bed of Joe Ajax's pickup truck in Glen Ellen, Calif. The whole unit lifts off when it's not needed. Folding brackets hold the lid up for loading. When closed, it won't obstruct the rear view, yet protects the load from rain and road



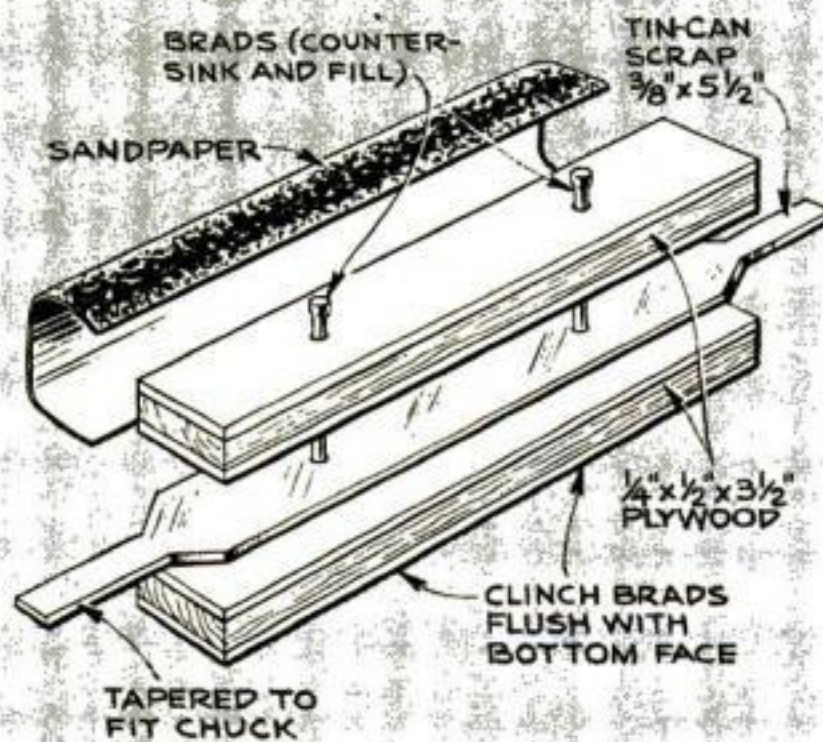
dirt. Add a hasp and padlock to burglar-proof it.—*Bob Gilmore, Sonoma, Calif.*



Self-Draining Sandbox

WANT a rugged sandbox that stays dry and won't rot out? Nail together a bottomless frame, brush on preservative and paint, and place it over a shallow drywell. Dig the hole 6" deeper than the frame and fill the extra depth with stones before setting in the frame. In rainy areas, a short, pitched-down lead-off will improve the drywell action.—*C. A. Huntington Jr., No. Attleboro, Mass.*

▶▶▶ WHEN a tube of glue, oil paint, grease, or patching putty springs a leak, it's not much good as an applicator. To close a puncture or crack, clean off the leaking substance and daub on a patch of epoxy-resin cement.—*Lauren S. McCready, West Redding, Conn.*



Sanding Fixture for a Jigsaw

TO AVOID sanding intricate fretwork by hand, I made this simple attachment for my jigsaw. Sandpaper is glued around a sandwich of tin and plywood (or half-round moldings, for a curved block). The ends of the tin strip project to form tongues for chucking in the machine. Dimensions depend on your jigsaw; the lengths specified in the sketch fit mine.—*Stephen Stana, Greensburg, Pa.*

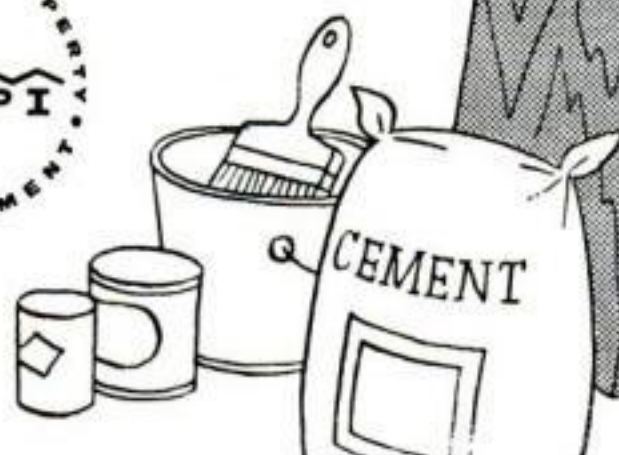


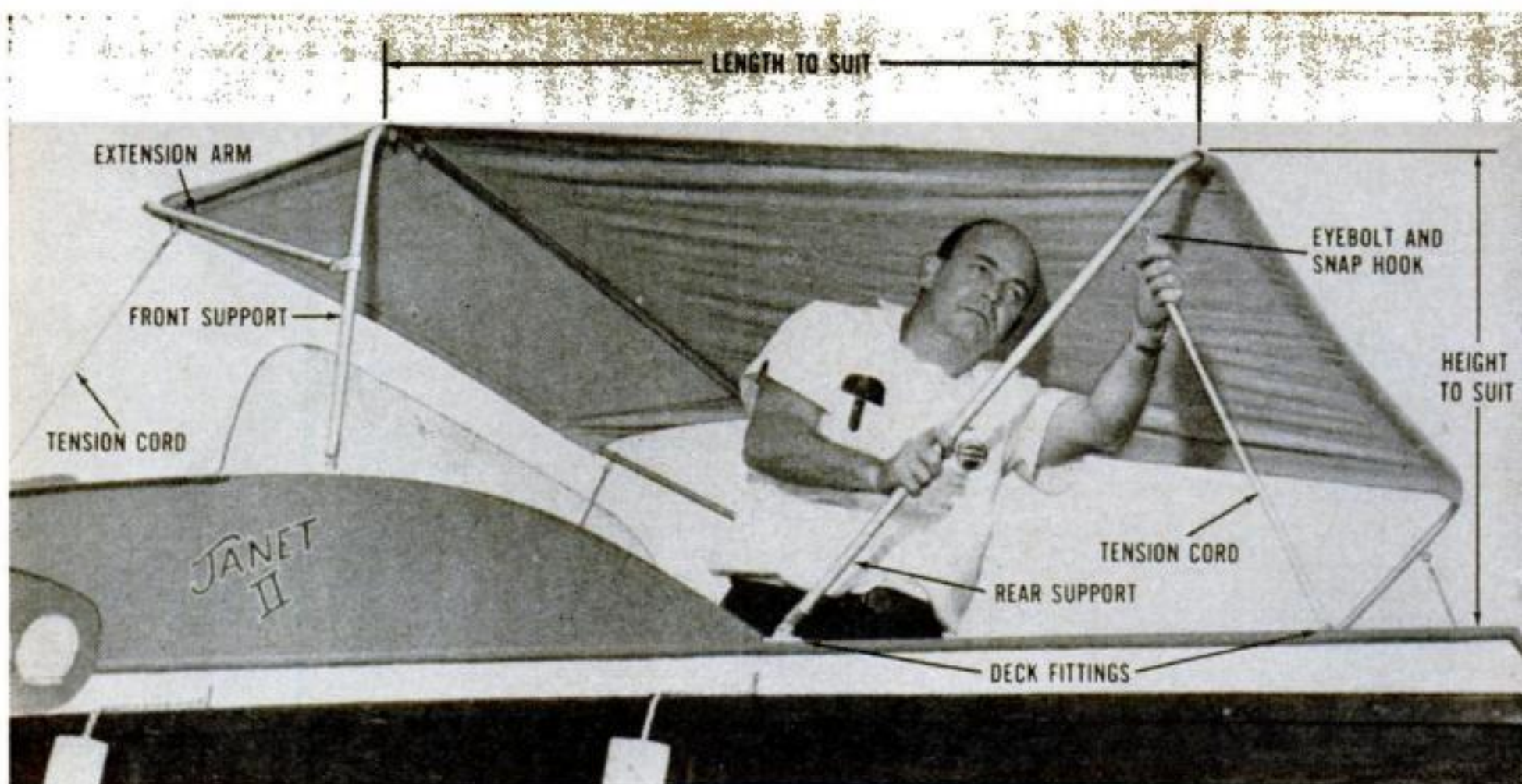
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How to Make a Convertible Boat Canopy

SUNSHINE, shade, or shelter from downpours—you can have your choice with this easily made, fold-down boat canopy. Mine cost \$19, a third of the price of a commercial equivalent.

Dimensions should be suited to the boat. Measure the area you want under cover, and decide on a height that permits comfortable standing (or sitting, depending on the boat design).

Buy a good waterproof grade of lightweight duck. If there's no local canvas shop, try an auto-top store. Often, for an extra buck or two, you can get the material sewn to order. If not, you can stitch duck on most sewing machines.

When you lay out the canvas, allow

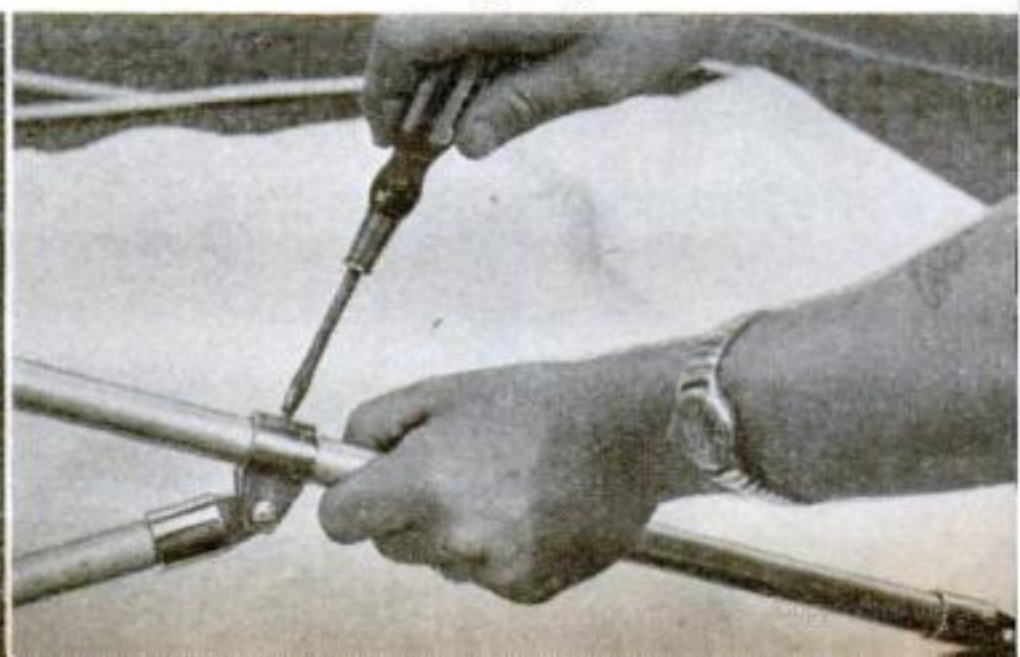
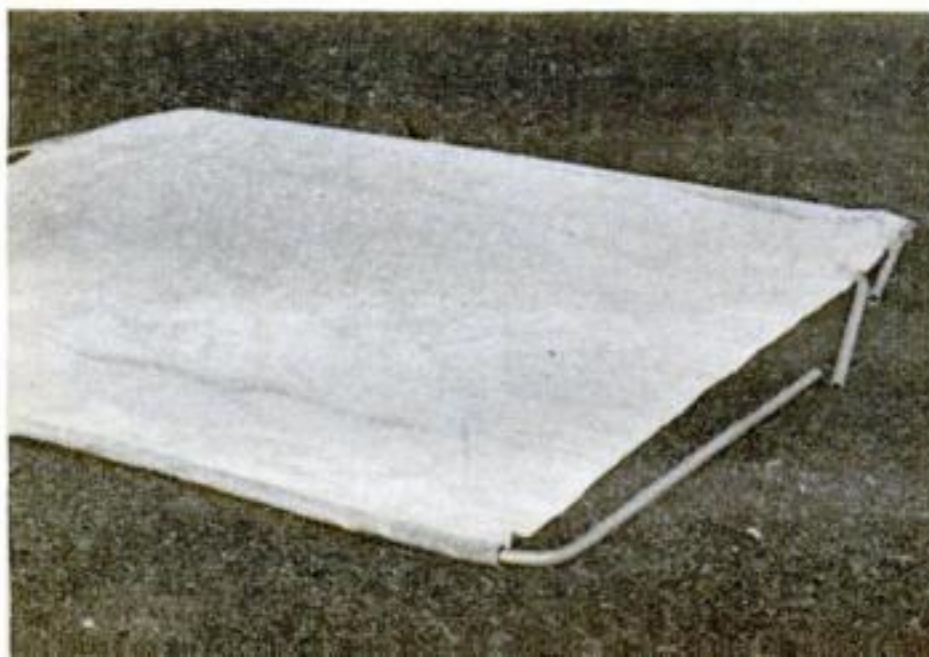
4" along each side for a sturdy hem, and add 12" to the length for the end laps the tubing runs through. If you want to anchor the canvas to the front support as well, you can make 4" sleeves by just slitting and cross-stitching the hems.

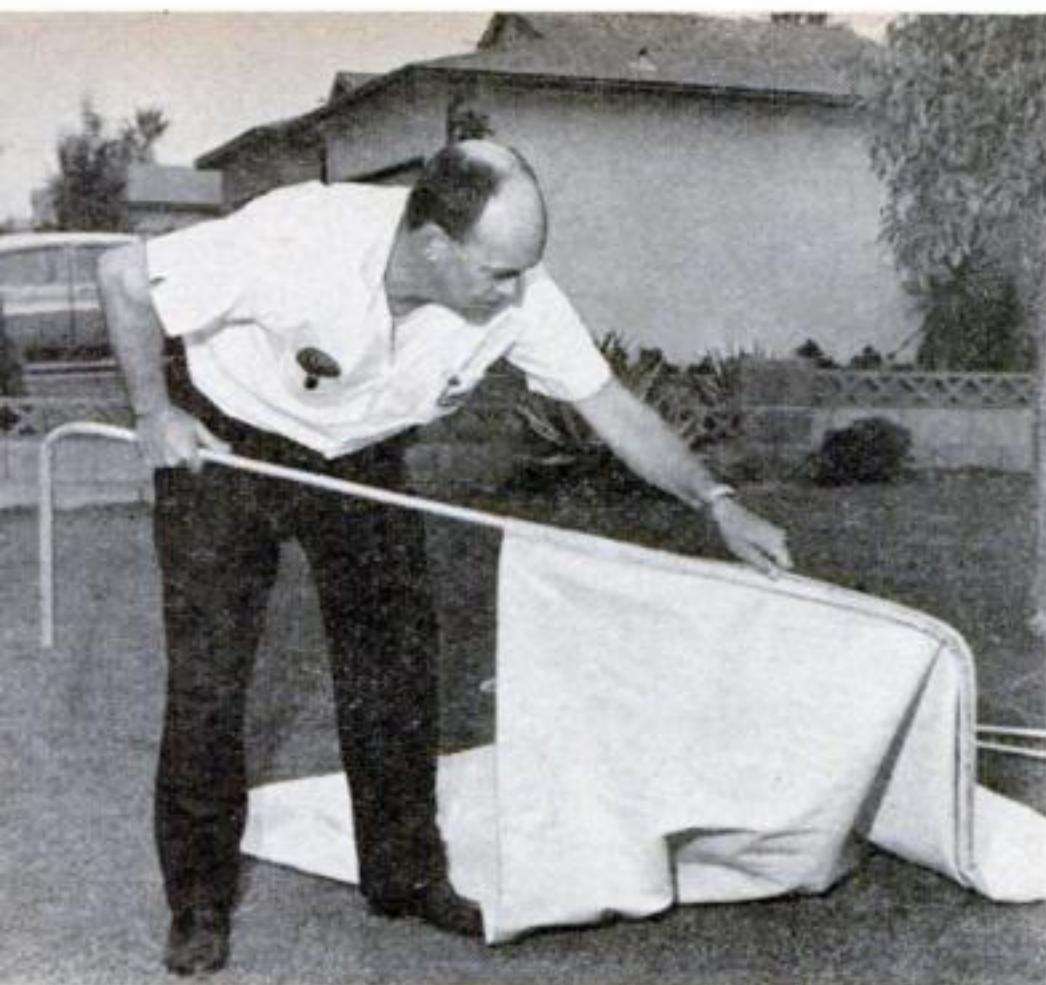
Buy the fittings first. It's easier to find tubing to match the inside diameter of available fittings than to start with the tubing and hunt for fittings of the right size. Mine are $\frac{5}{8}$ ", and I bought thin-walled conduit to fit. Since I took my measurements along, the hardware store made the bends for me. If your dealer is less accommodating, rent or borrow a conduit bender.

Before permanently fastening the

BEFORE ATTACHING FITTINGS, lay assembled canopy flat to check whether crossbars are parallel. At this stage, duck can still be slipped off to correct hems in canvas or bends in metal.

JOIN EXTENSION ARM to front support with slip-on swivel fitting. Don't cinch it tight until canopy is erected. After adjustment, tighten the setscrew to lock fitting in position.



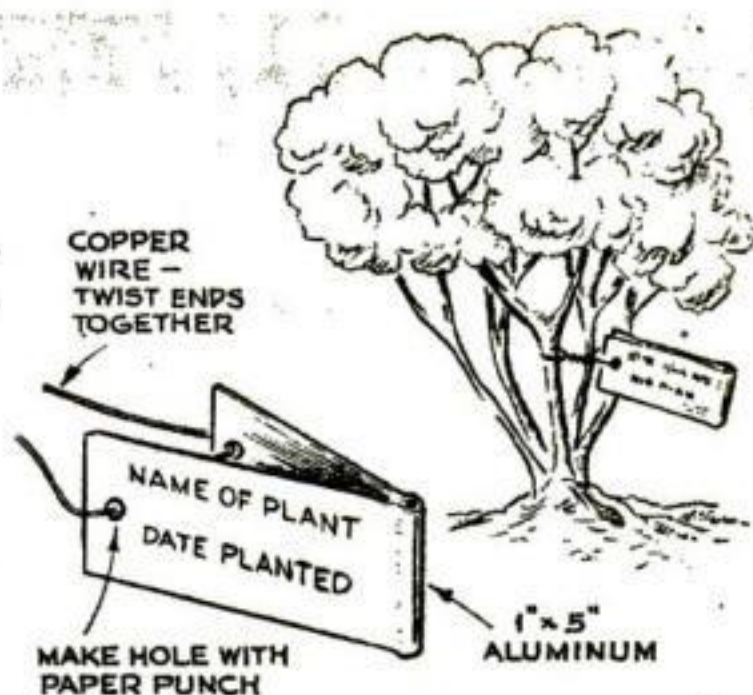
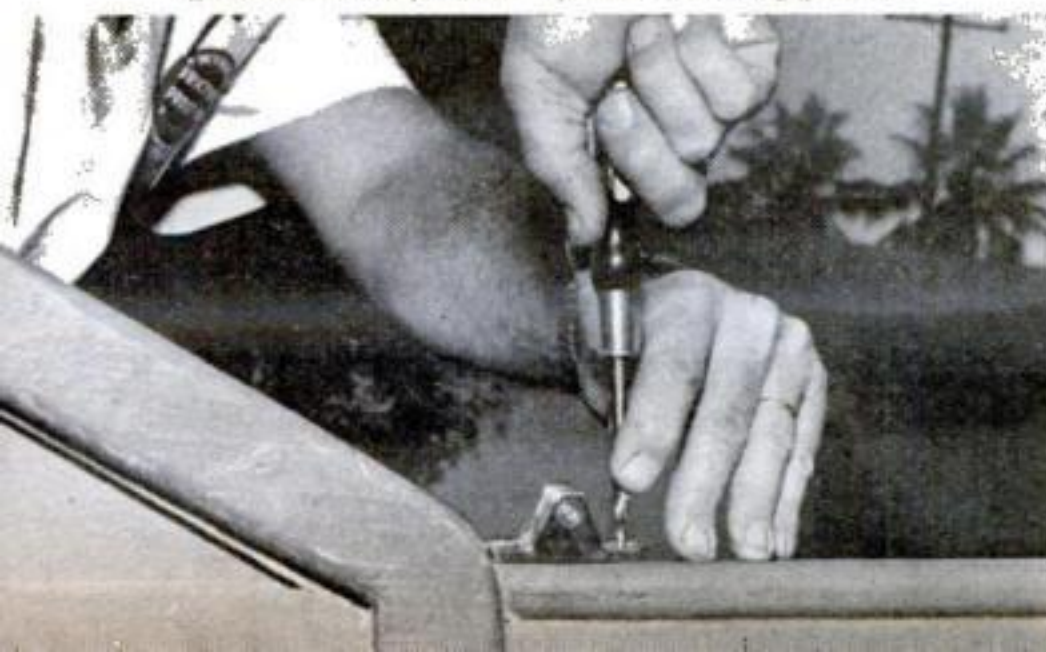


INSERT BENT TUBING through end hems in the canvas. Don't anchor with rivets: The fabric may shrink and tear as it weathers. Tension alone is enough to keep it from shifting.

deck fittings, test the folding action of the assembled canopy. It should flatten back (rather like a sports-car tonneau cover) when you release the front tension cords. Be sure it leaves comfortable access to the controls.

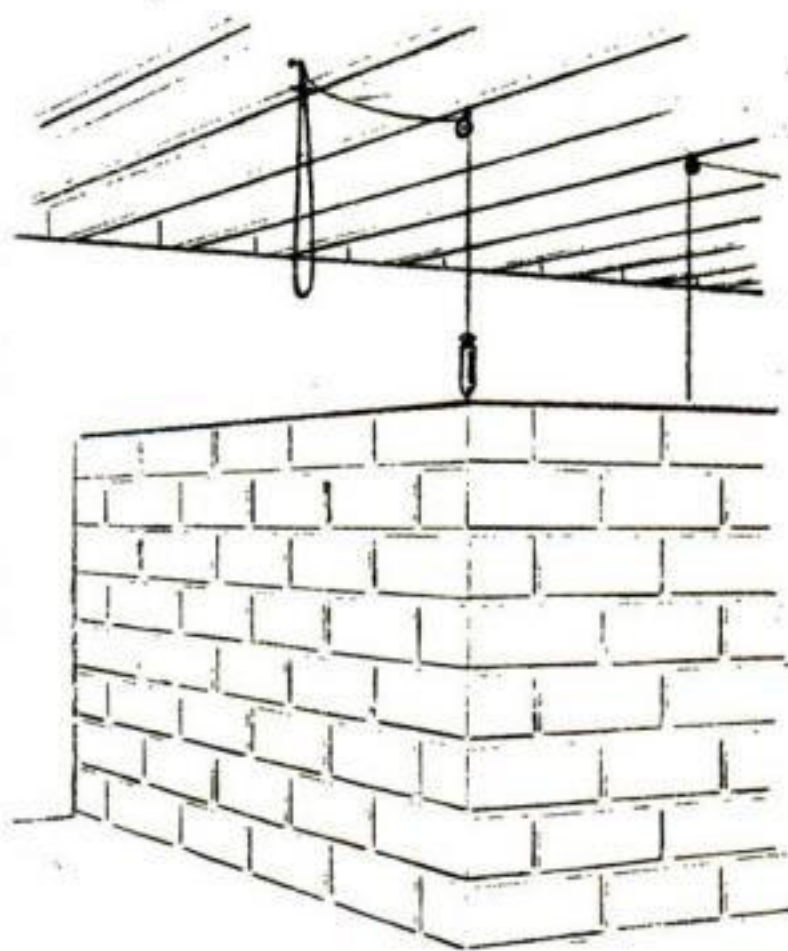
The tension cords can be elastic shock cord, or plastic or nylon splicing line (I find that plastic line holds up best). Fasten one end of each line to a deck cleat. To determine proper lengths, have a helper position the canopy while you draw the cords up into place. Cut them enough overlength to run through the eye of a snaphook. Stretch them taut again to locate the eyebolts in the supports.—*Victor W. Kondra.*

LOCATE SWIVEL BRACKETS for the rear supports by holding the canopy in position. Attach with brass screws or bolts. All fittings are chrome-plated brass, sold by marine suppliers.



Permanent Plant Tags

I USED to tie small wood labels on my plants and shrubs, but the lettering soon weathered away. Now I cut tags from aluminum oil cans, using a paper trimmer. A quart size makes a dozen labels. I scratch the name and date into the surface with a dry ball-point.—*Terrell Nichols, Bowie, Tex.*



Traveling Plumb Bob

KEEP corners vertical when laying brick by rigging an adjustable plumb line. Use a bob to position a screw-eye above the critical point. Run the line through the eye and anchor it by winding around a nail. As you lay each course, hitch the bob higher.—*C. A. Huntington, No. Attleboro, Mass.*

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Here's an unusual lathe job:

Tiny Compressor to Blow Chips

By Henry Frostick

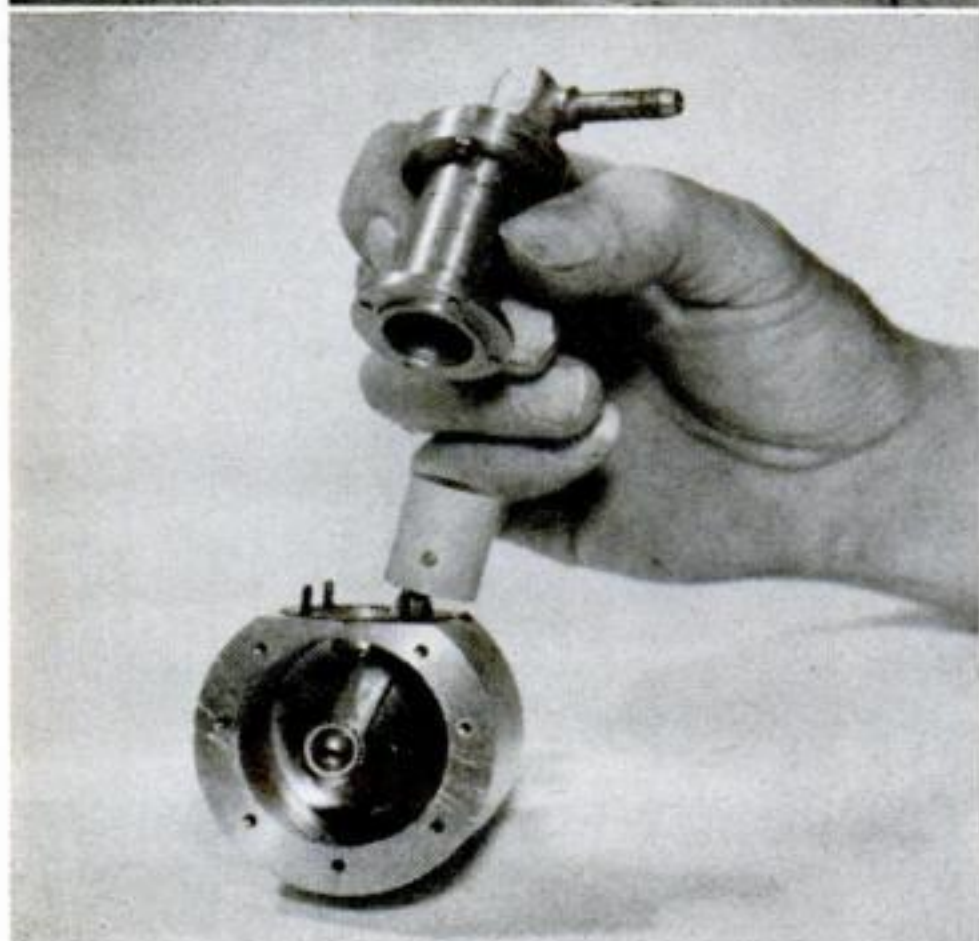
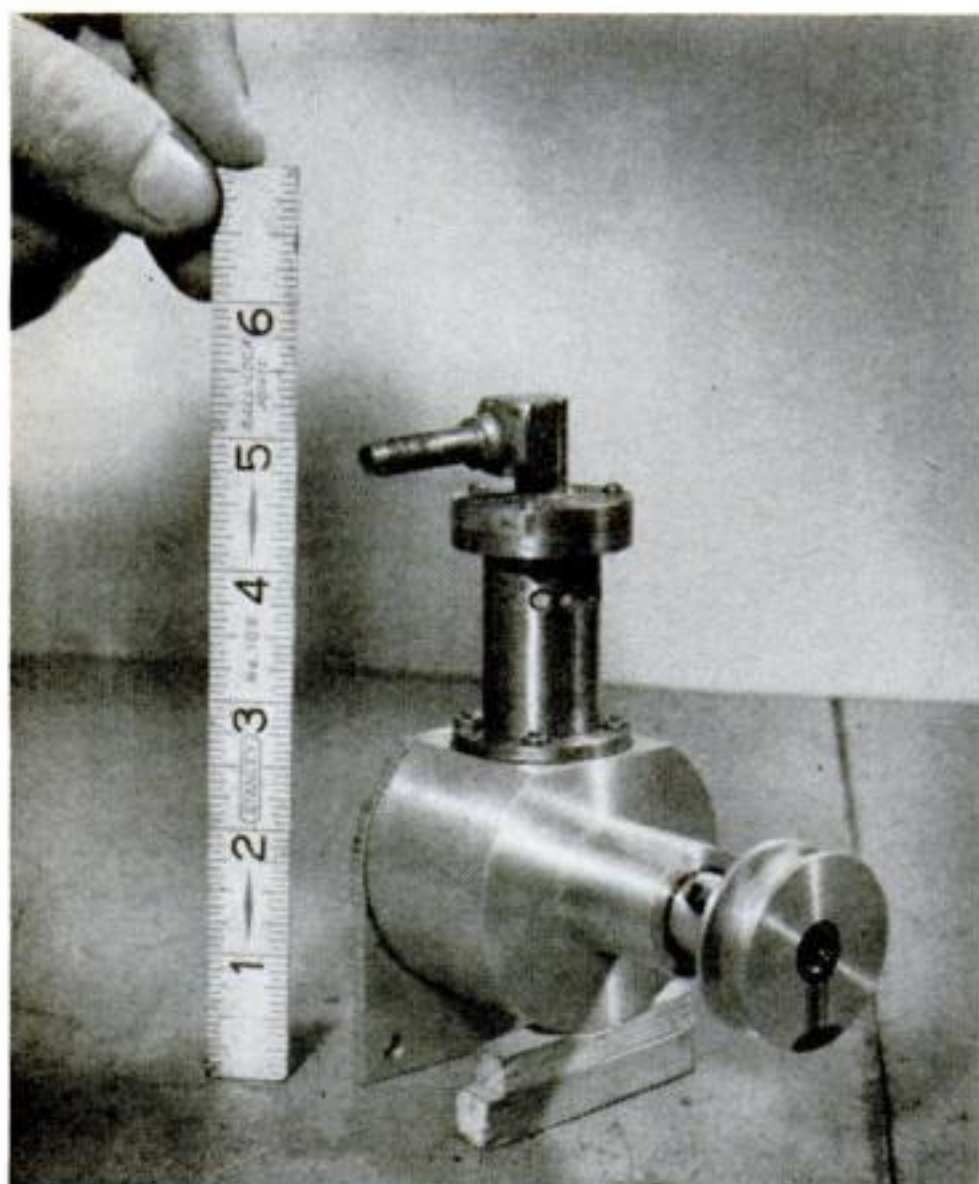
MAKING this baby air compressor is a fine exercise in machining—and you come out with something useful at the same time. I use it to clear chips from my bandsaw—and it really blasts them. It could also be set up to blow dust from a sander or jigsaw or to clean small parts.

Air volume is small (not enough for spraying paint), but there's plenty of pressure. Belt-driven by a little 1/6-hp. motor, the single-cylinder compressor puts out 40 pounds—enough to inflate an auto tire. It can also be driven off the same motor that runs the tool it's used on. In this case, it's easiest to connect the compressor drive shaft directly to the motor shaft with a flexible coupling.

Construction isn't difficult, but it offers some interesting operations. The cylindrical crankcase is turned in one piece, including the long shaft bearing at the front. A cover plate at the rear seals the crankcase and extends on down below it to form a mounting bracket.

The single piston is turned from aluminum and rides in a steel cylinder. Small holes in the side of the cylinder serve as inlet ports when the piston is on the downstroke. A ball-check valve at the top keeps discharged air from rushing back in during the intake cycle. You may be able to find an old junked fitting to serve here. If not, the drawing shows how one can be made.

In use, the crankcase is filled with light oil (No. 10) to the level of the crankshaft. A gasket under the cover plate prevents leaks, but the cylinder must be mounted upright to avoid oil fouling. Air is piped through rubber tubing (windshield-wiper hose is fine) from the check valve to the work area.



PISTON AND CRANKSHAFT can be seen in this rear view with cylinder and cover plate removed. Wrist pin is tight fit in piston, loose in con rod, to avoid scoring cylinder walls.

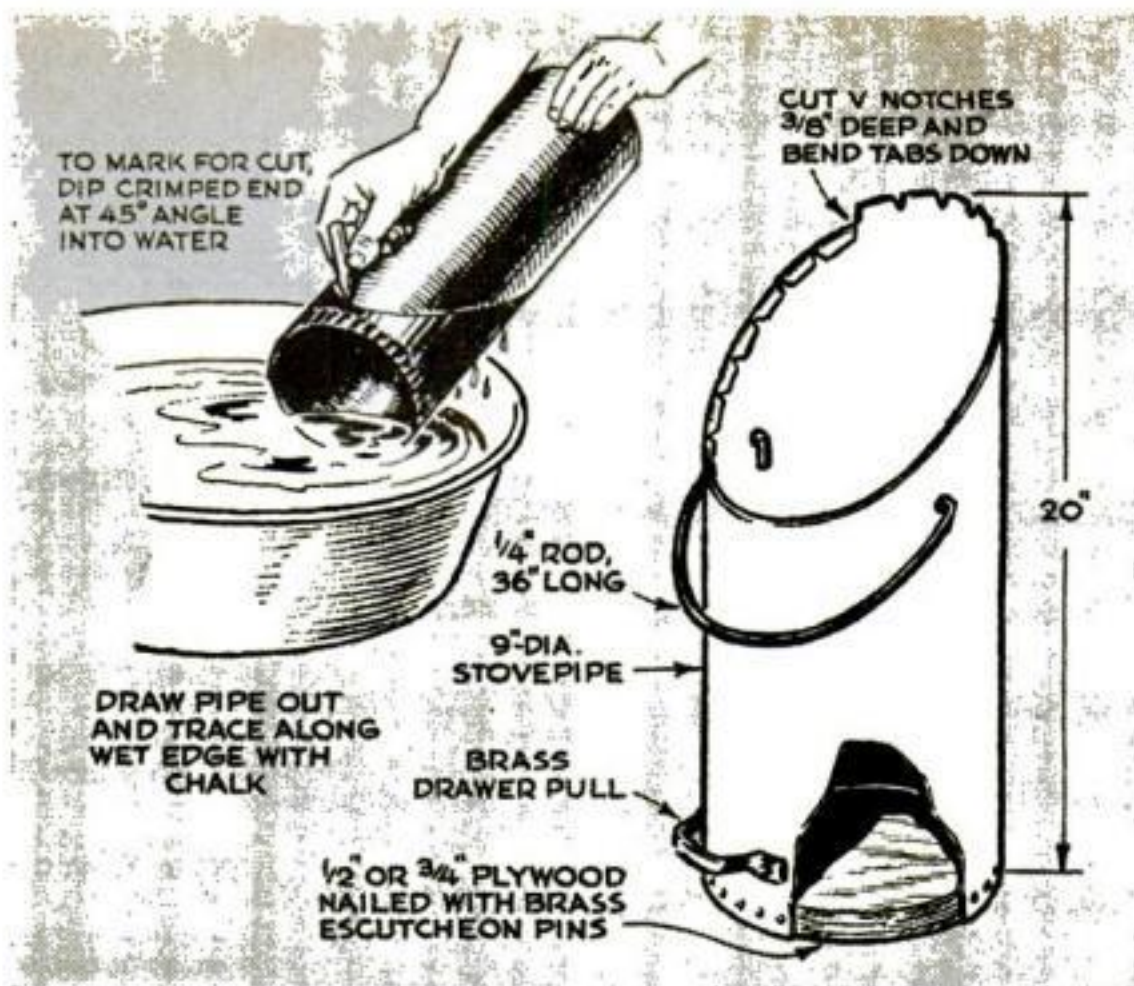
Short Cuts and Tips

FROM PS READERS

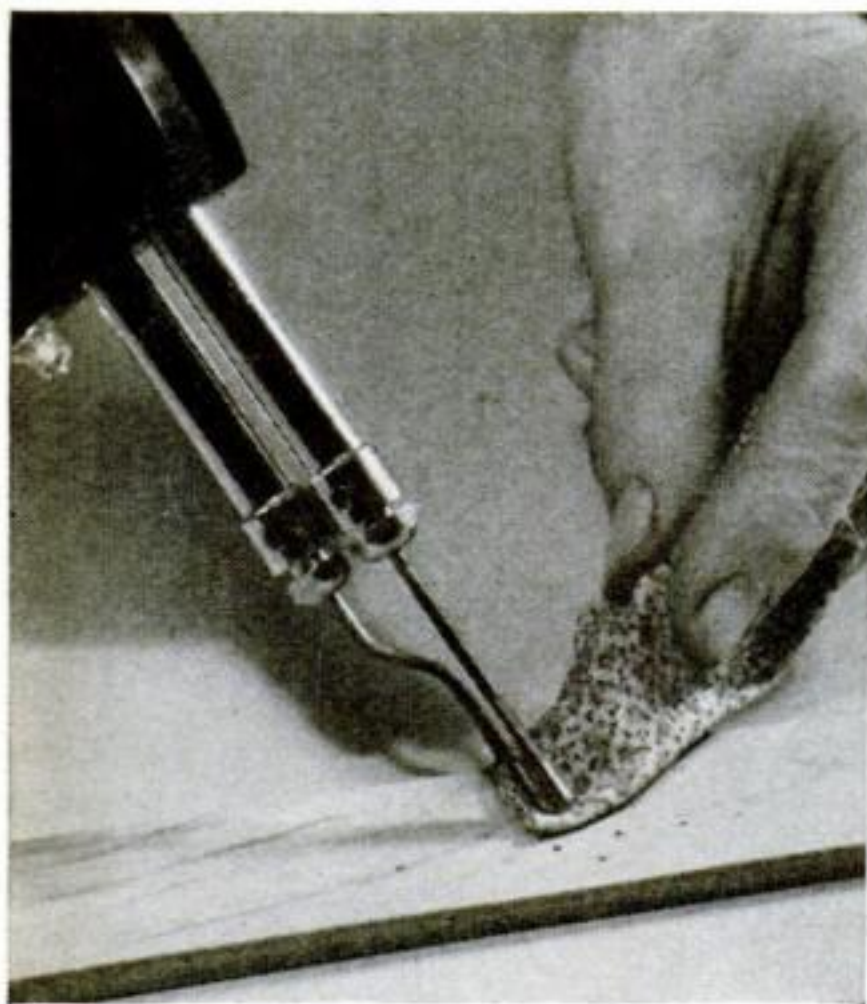
Barbecue Scuttle from a Stove Pipe

THIS clever stove-pipe scoop helps you lay just the right amount of charcoal in your back-yard grill—without blackening your hands or clothes. Brass-plated curtain rod is fine for the handle. The drawer pull, riveted to the low side just above the plywood bottom, provides a handgrip that gives you firm control.

To take the scuttle indoors, calk the bottom inside where metal and wood join



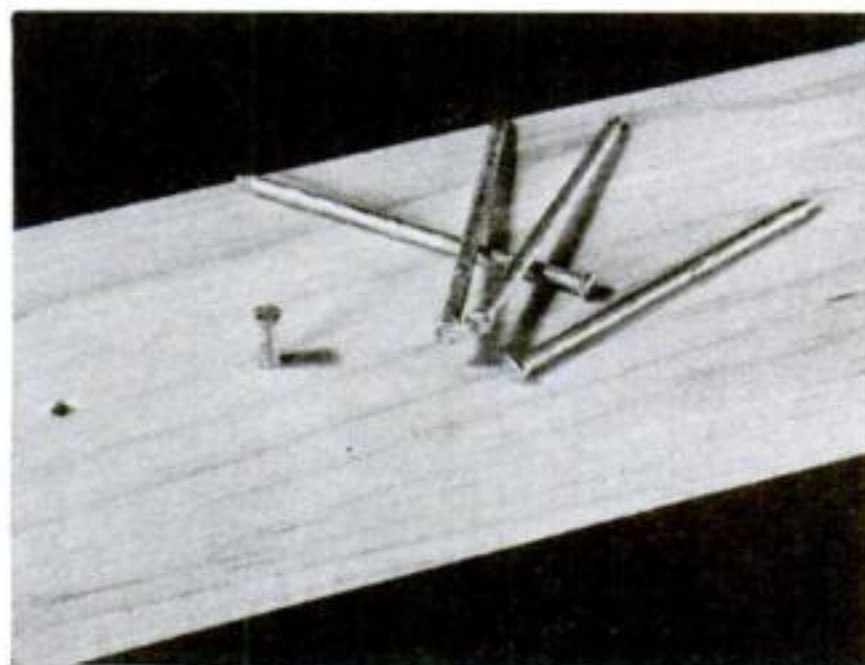
so that coal dust can't sift out.—*H. A. Fluchere, Irvington-on-Hudson, N. Y.*



Shrink Nail Holes with Steam

WOOD surfaces are often marred by brad holes, left when two pieces are tacked together temporarily. Usually, they're so small that it's difficult to fill them neatly. Solution: Try a steam treatment. Place a fold of moistened cloth over the hole and apply a hot soldering copper. The resulting steam expands wood fibers compressed by the brad, closing the hole so it won't show under a finish coat.—*Walter E. Burton, Akron.*

▶▶▶MY PLYWOOD Ping-pong table does double duty. I brushed green blackboard paint on the playing surface, white enamel on the underside. When I tip the table on edge, I've got a king-size movie screen.—*C. F. Wilson, Moose Jaw, Sask.*



Nail Subs for Nail

WHEN racing to complete a project have you ever run out of finishing nails? You can clip or grind most of the head from a box nail of the same gauge.

▶▶▶TO KEEP precision tools from rusting in my damp shop, I store them in a closed box and toss in a couple of moth balls. The harmless vapor from the evaporating moth balls displaces moisture.—*Melvin Look, El Cerrito, Calif.*

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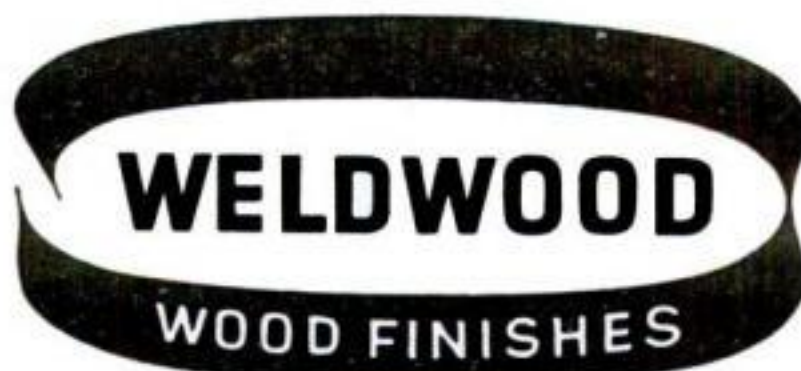


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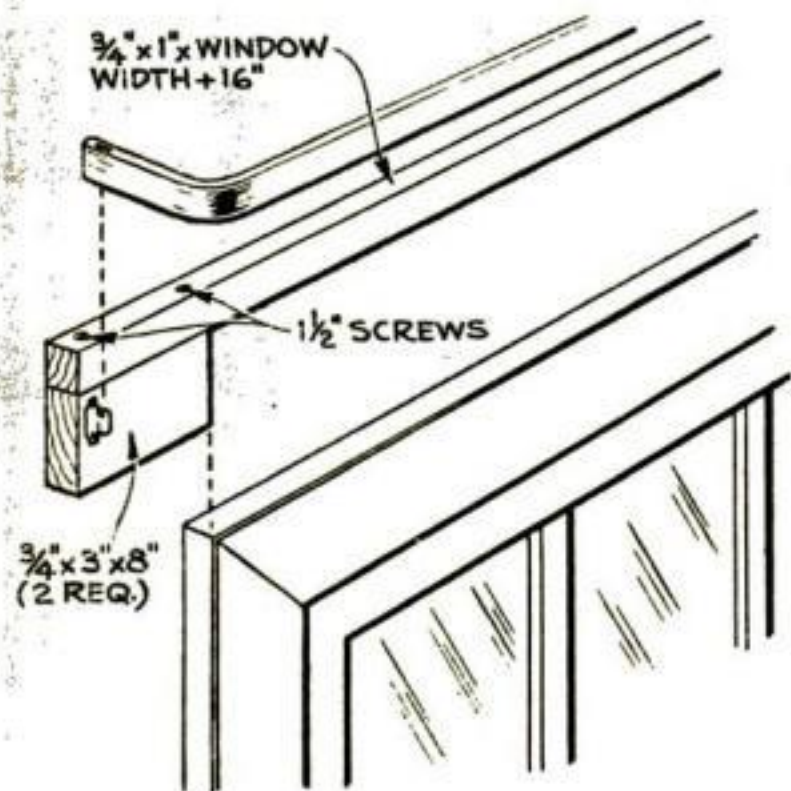
How handy to have supplies at your fingertips when you need them! It's easy. Keep these Weldwood[®] adhesives and finishes on your workshop shelf, and you're set for practically every job, indoors or out: Firzite, Exterior Stain, Spar Varnish, Resorcinol Glue, Wood Preservative. Total cost: only a few dollars. And you save yourself time and trouble! Shop your lumber yard or paint and hardware stores this week.



Products of United States Plywood

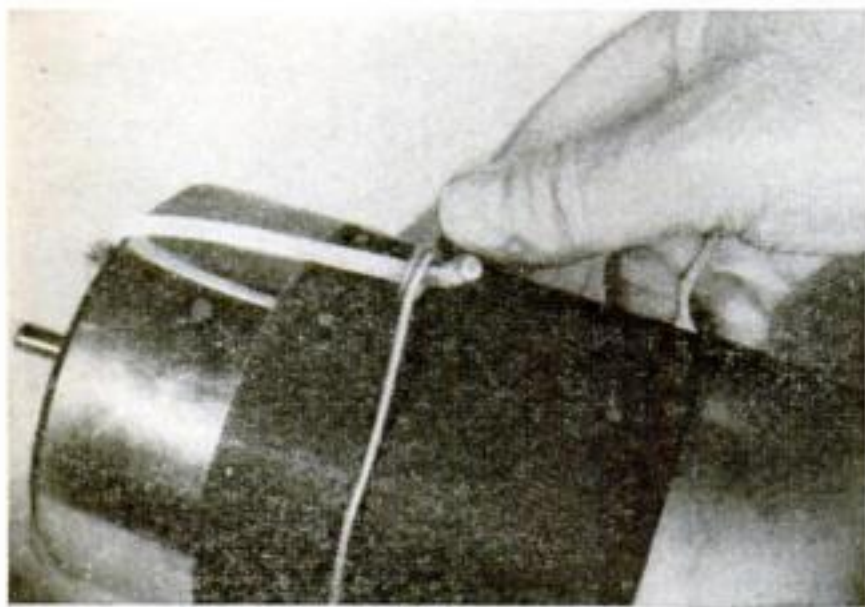
Short Cuts and Tips

FROM PS READERS



Make Your Windows Wider

YOU can make a narrow window look wider—and let in more light—by hanging the side drapes so they overlap the wall, not the glass. Use a curtain rod longer than the casing is wide. To anchor the rod hooks without marring the wall, make the extension yoke shown. Tack it on top the casing.—*A. E. Bryant, Lynchburg, Va.*



Tube for Tight-Spot Oiling

BEFORE mounting an electric motor in a spot where the oil hole won't be accessible, make provision for remote oiling. Slip one end of a small metal or plastic tube as far into the oil hole as it will go. Fold the other end back over the motor to some location you can reach with an oilcan.—*Ken Murray, Colon, Mich.*



Behind-the-Door Blackboard

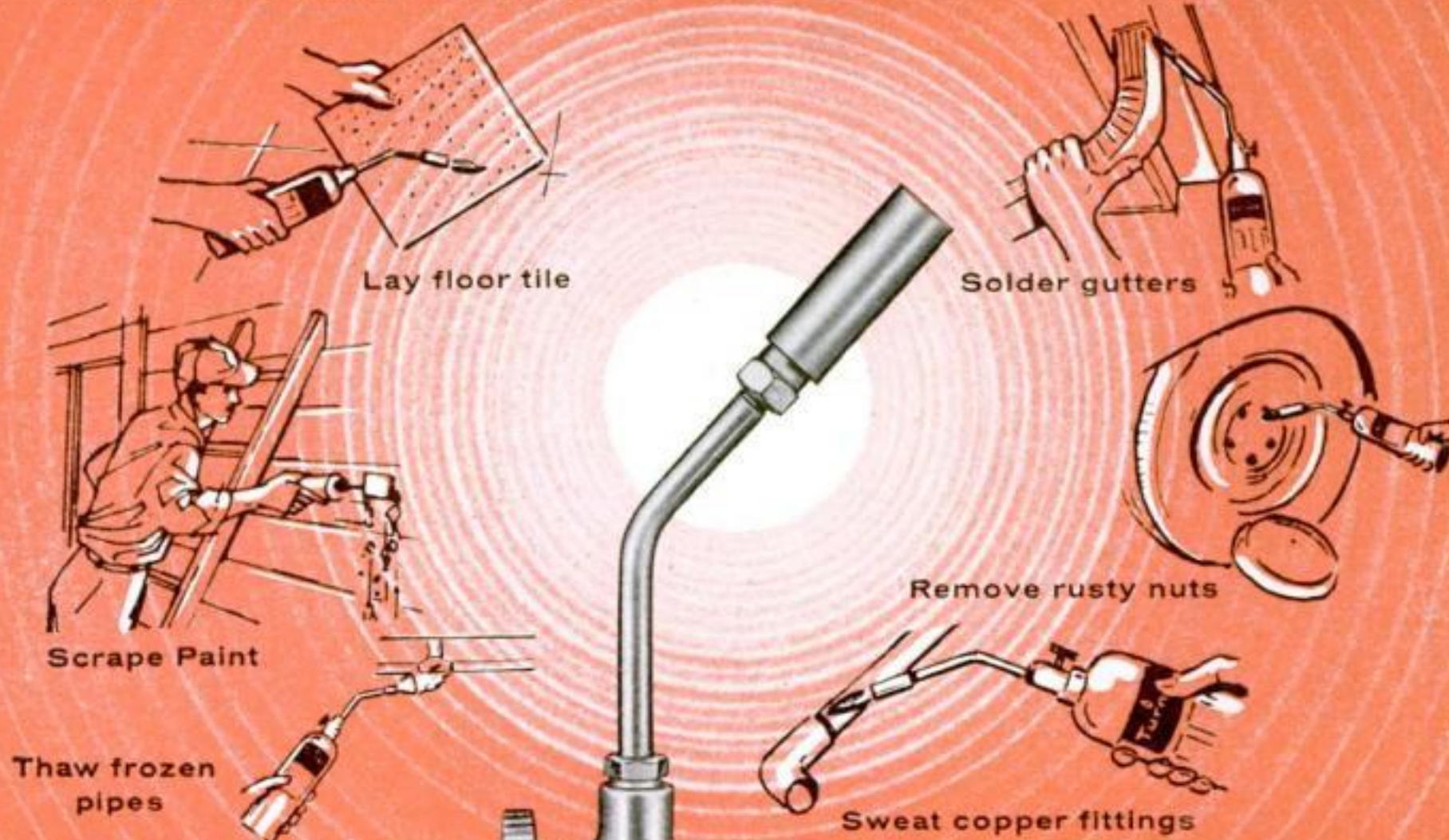
WANT a man-sized blackboard to list a schedule of chores or shopping needs? It will swing out of sight if you locate it on the back of the door to a closet or pantry—or even a wall cupboard. If the surface is flat, you won't need slate. Just brush on two coats of blackboard paint.—*William E. Cook, Falls Church, Va.*



Ladle for Melting Lead

TO MAKE a melting ladle, set a section of 4" pipe on flat iron plate, trace around it, and cut out the disk with a torch. Weld this to one end of the pipe. Forge a pouring lip at the other by heating the rim red-hot and striking it with a ball-peen hammer. Weld on 1" pipe for a handle.—*H. J. Gerber, Menomonie, Wis.*

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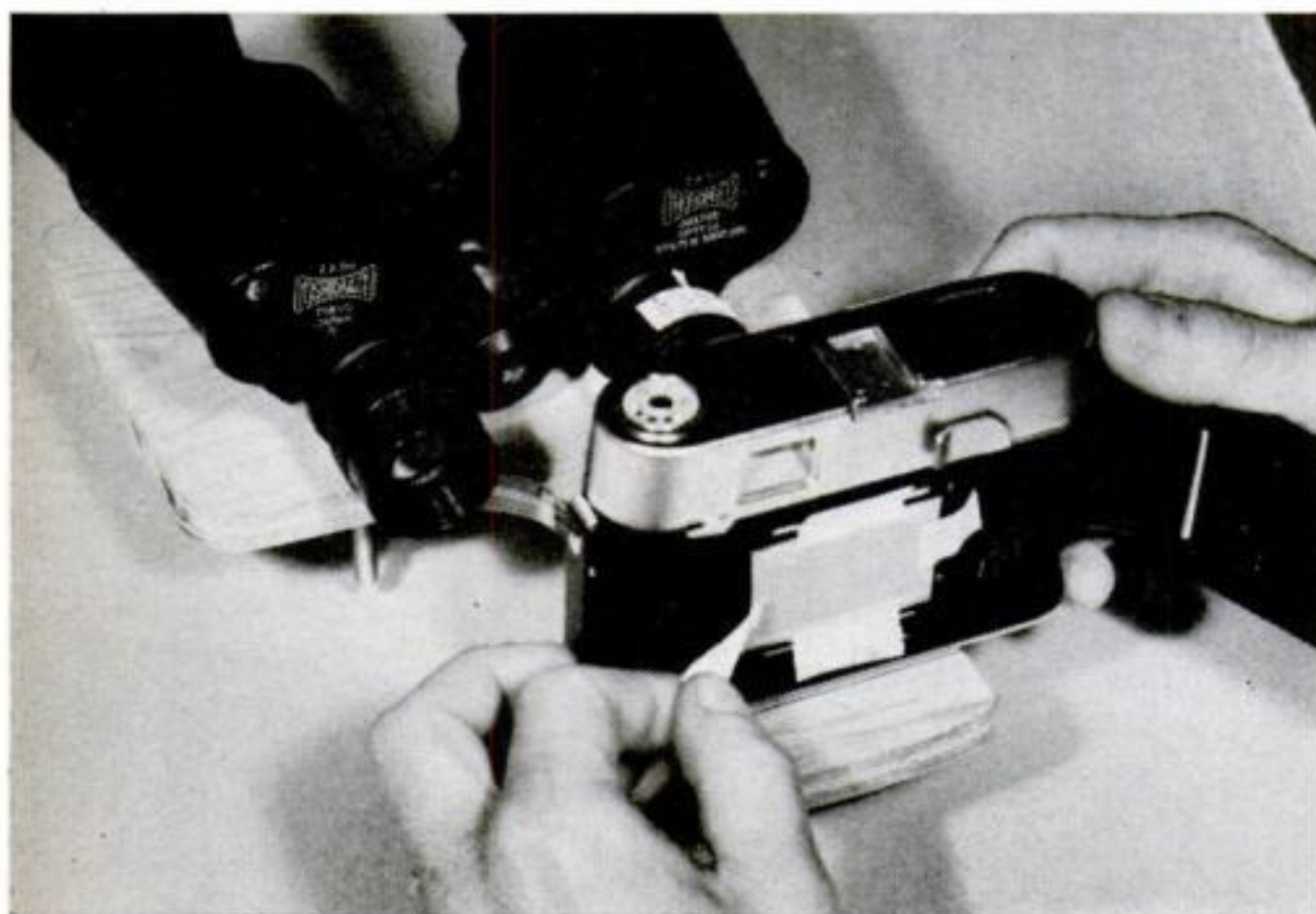
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LOOK FOR THIS SIGN OF QUALITY



Focus this way on non-reflex cameras: Tape a thin sheet of opal glass or frosted plastic over the film plane and test-focus a number of objects at known distances. By marking the settings on the camera's focusing scale and binocular's eyepiece with tape, you can repeat them later for sharp photos. When taking actual pictures, sight through the unused binocular.



Enlarged more than four times, barn at right was snapped from same point as conventional long-distance view at left. The only difference: A pair of 7x50 binocs made close-up.

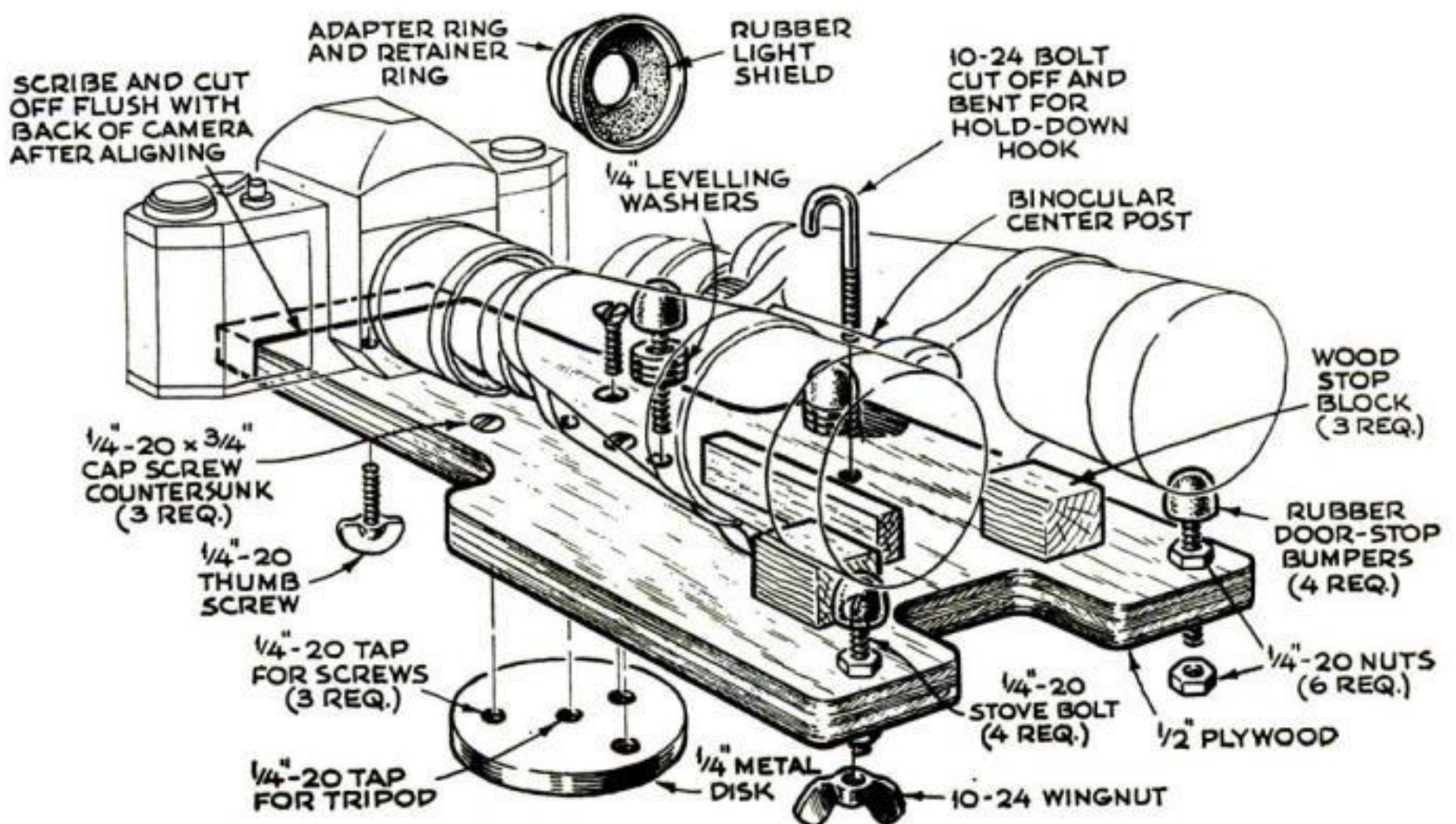
How to make a plywood bracket for Shooting Telephotos with Binoculars

By Phil McCafferty

HITCH a pair of ordinary binoculars to a 35-mm. camera and you have an economical rig for capturing those breath-taking close-ups that normally can be made only with a telephoto lens.

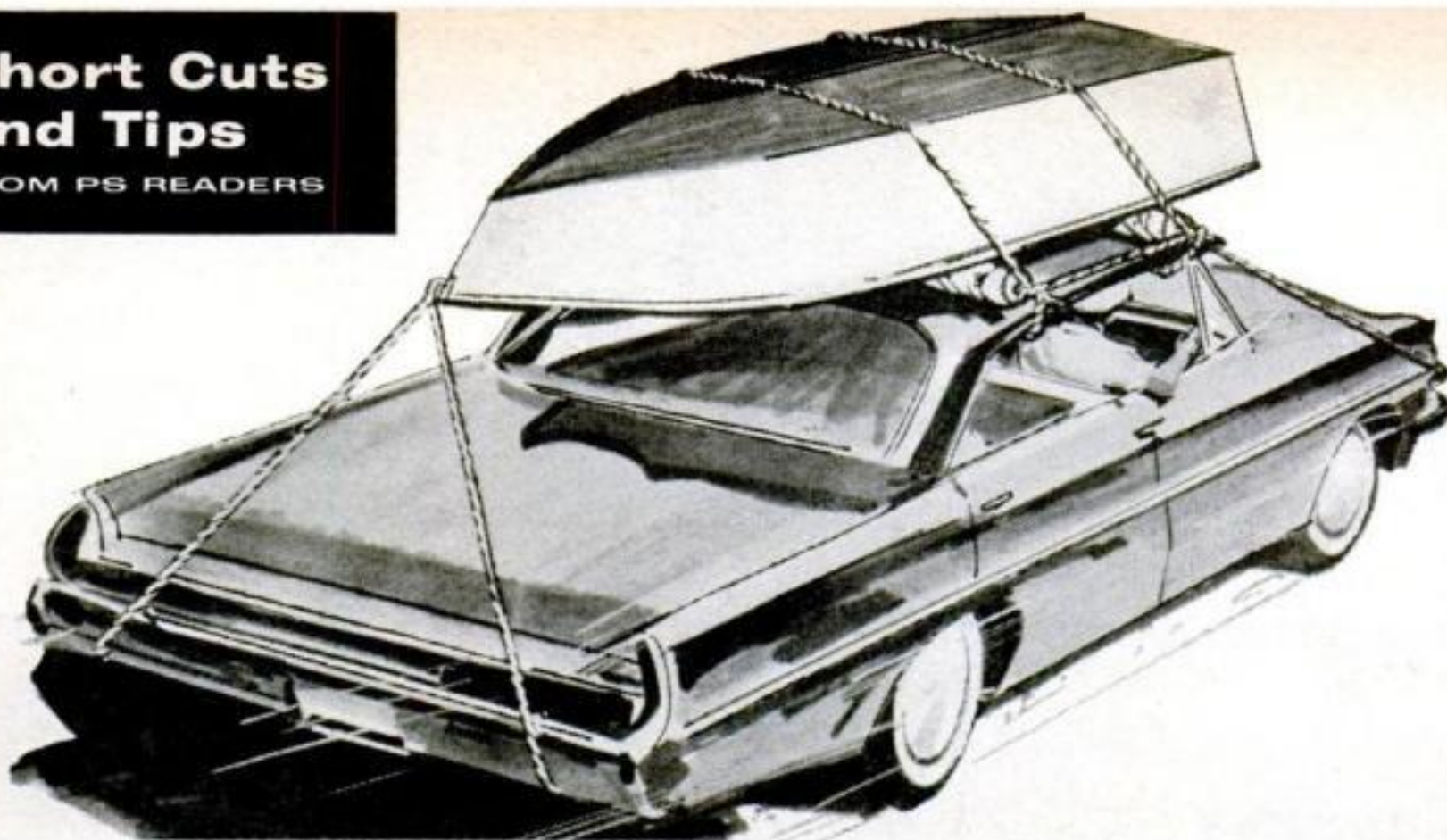
Regular telephoto lenses are expensive and aren't available for many 35-mm. cameras. But for a dollar you can make a bracket to couple binoculars to your camera. With a little care, you can turn out distance-shrinking photos that come close to rivaling

[Continued on page 208]



Short Cuts and Tips

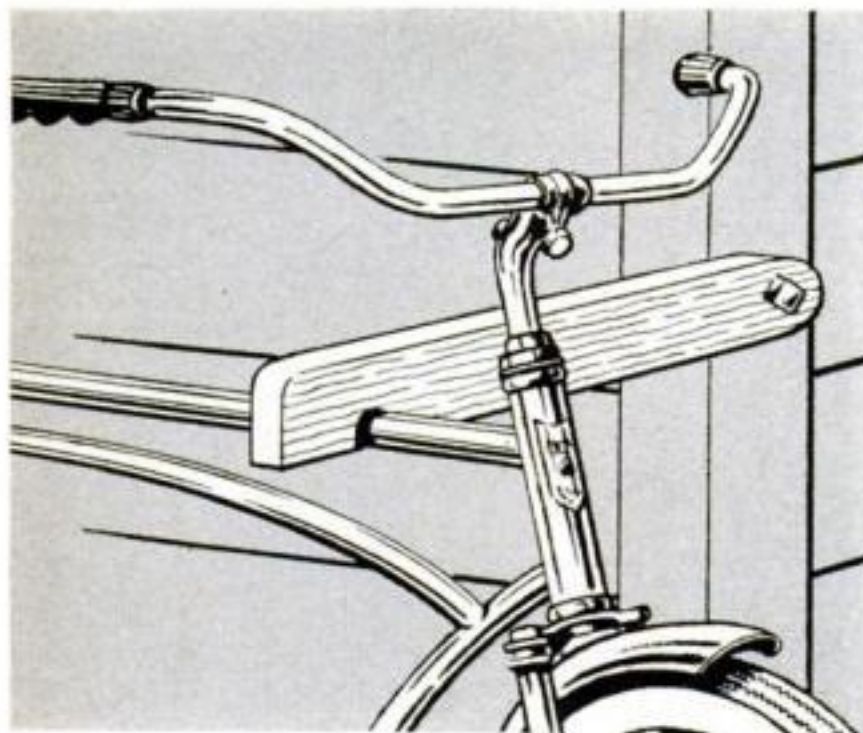
FROM PS READERS



Temporary Carrier for Car Top

WHETHER you want to cart a boat or long pieces of material, this improvised car-top carrier will come in handy. You'll need two poles or one-by-twos at least as long as the car top is wide.

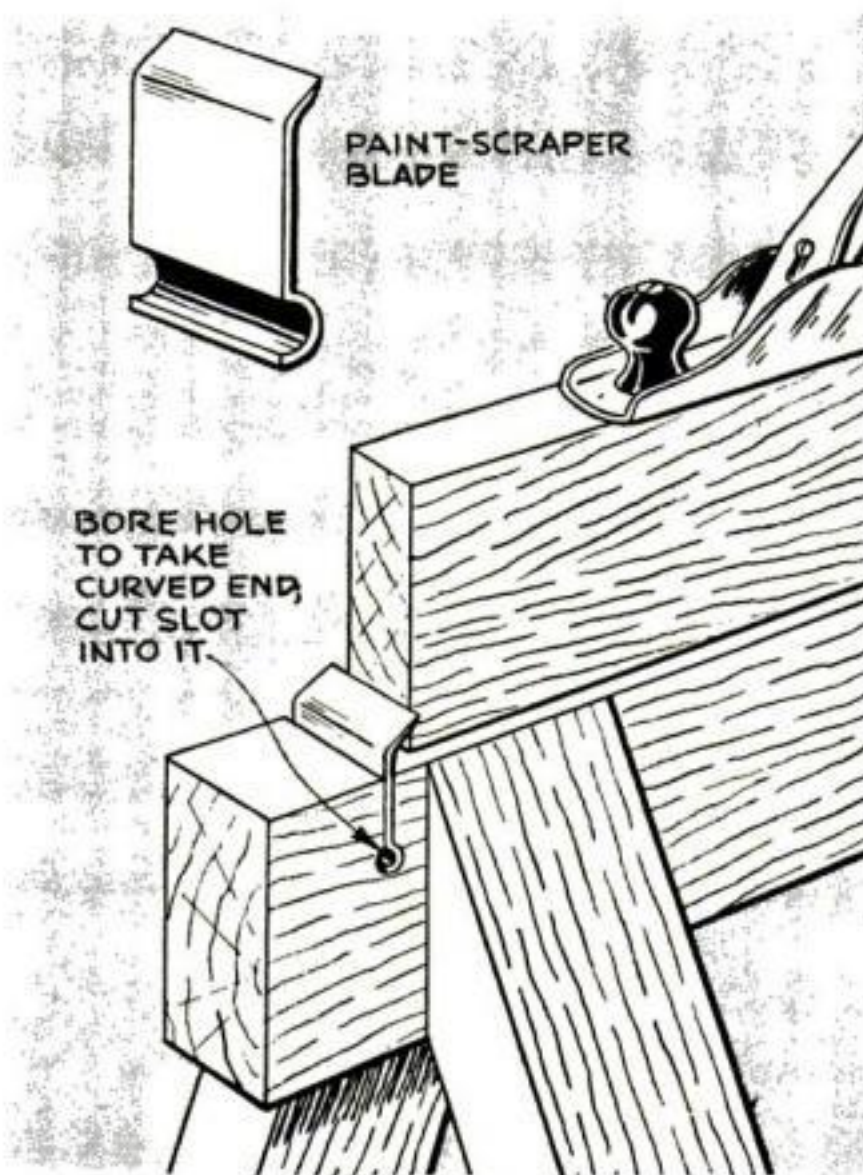
▶▶▶MAKE whisk brooms last longer by coating the bristle tips with thinned white shellac. This makes the bristles tougher without reducing flexibility.



Parking Spot for a Bike

ENCOURAGE your boy to park his bicycle safely out of the way by pivoting a notched board to a corner of the garage or other outbuilding. The board, swung up and dropped down so that the notch engages the crossbar, supports the bike in an upright position, ready for use.—G. E. Hendrickson, Argyle, Wis.

Wrap the four bearing points with old clothes, burlap, or newspaper. Tie clothesline across the protruding ends. When the load is in place, lash it down, passing the rope through the windows. Finish off by tying lines to each bumper.—Thor Lindstrom, Seattle.



Planing Stop for a Sawhorse

NEED to edge-plane short boards away from your workbench? No problem, if you equip your sawhorse with this removable stop.—G. E. Hendrickson.



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*Gus lifted the rag off
the generator and
held it up. On it were
two fresh oil spots.*

Gus Wins an

By Martin Bunn

THEY just don't make cars like they used to," asserted Dave Rankin, reaching along the Okay Diner's counter for the salt.

Gus slowly buttered a roll. "That doesn't mean they aren't better."

"I'll say," put in Doc Hockenjoss. "That '59 six I bought from my brother-in-law is more automobile than any you ever went courting in, Dave."

Rankin grunted, his sallow cheeks working. "Don't mean that far back. Take that '55 V-8 I've got. It has 60,000 miles

on it and it guzzles oil. But I'll bet you have trouble with your car on this trip 'fore I do."

"Twenty bucks," said Doc promptly. "Gus can hold the stakes."

"You're men enough to pay off your own bets," protested Gus. "Going far?"

"The boondocks," responded Rankin. "Doc knows a fishing spot in Cortway County where they bite on bare hooks."

The veterinarian nodded, eyes watering as he downed scalding coffee. "So far out you almost can't get there from here. I'm taking my car so we won't be stranded when his breaks down."



Easy Wager

"Waste of gas," grunted Rankin. "It won't be my car that conks out."

Both men got off their stools.

"In case I don't see you before you leave Friday," said Gus, "and in case you both get there—good fishing!"

GUS had hardly opened the shop on Thursday morning when a car rolled up at the Model Garage. Rankin stuck his glossy bald pate out.

"Got a small job, Gus. Can I park it in a corner some place?"

"Back of that pickup," said Gus.

The retired grocer parked his battered

hardtop and hitched his plump figure out of the car. "It ain't much, just the ammeter bouncing. Could you fix it fast?"

"Maybe, if it's only a loose connection." Gus quickly checked the battery terminals and connections at the ammeter and voltage regulator. All were sound, but with the engine running the ammeter needle flicked back and forth.

"Sorry, Dave. It could be anything from the voltage regulator to an out-of-round commutator or bad brush."

"Try a new regulator, will you?" asked Rankin, his eyes on the door.

"Expecting somebody?" asked Gus.

CONTINUED

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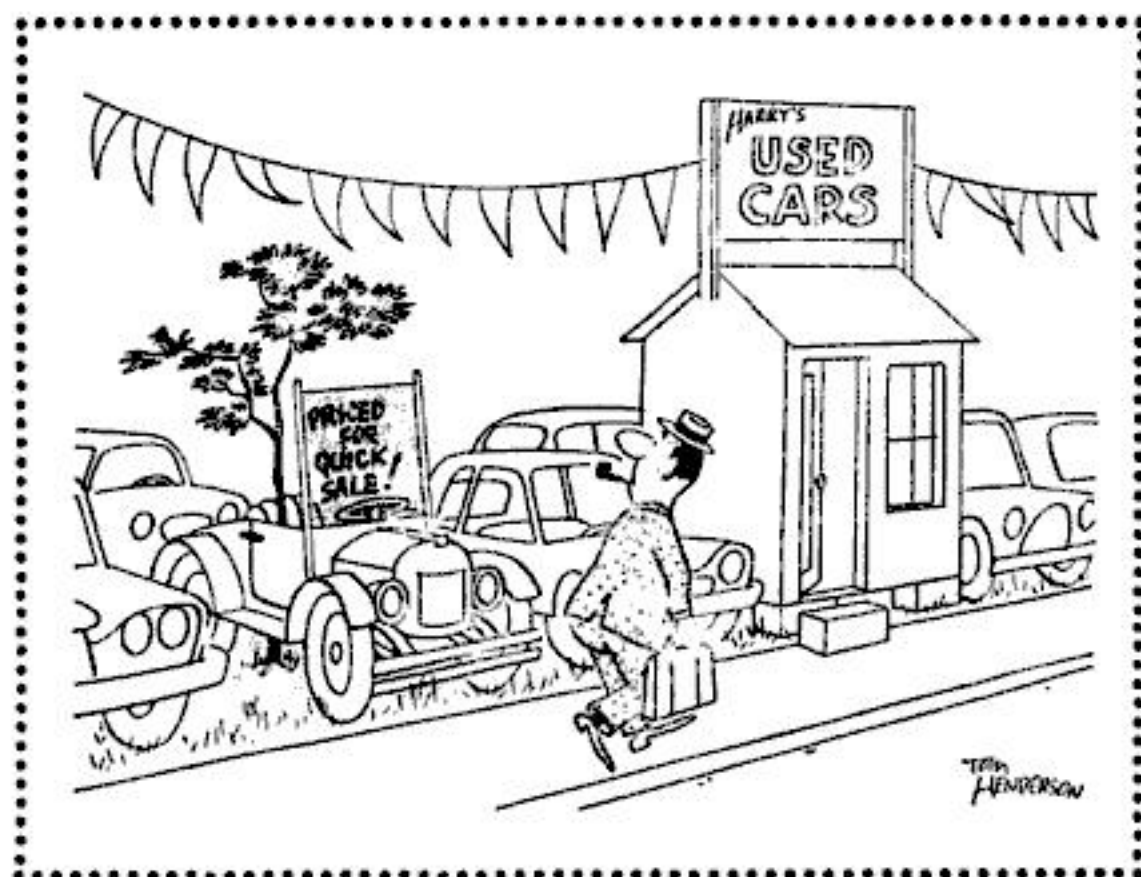
"Eh? Oh, no. Could you hurry it up?"

Finding the regulator points oxidized, poorly aligned, and filed thin, Gus installed a new unit. When it was connected, he started the engine again. The ammeter fluttered off the pin to full charge, fell back, flickered as before.

"No good. Have to check some more."

Rankin nodded glumly. "Okay. Don't want to be stuck with a dead battery out in the sticks. Er, Gus—could we keep this just between us?"

Gus smiled. "Your car's sort of hidden behind the pickup. Want me to see why you're losing oil?"



Rankin shook his head. "That don't bother me. I use cheap oil, and I'll take plenty along. Fix my chargin'."

Gus grinned as the paunchy little man peered up and down the street before stepping outside.

As Gus was about to take the generator off the car, a horn blared out in the shop. He walked over to confront Doc Hocken-joss in his '59 sedan.

"Got a little job for you, Gus."

"Didn't think you'd stopped to talk about the weather," retorted Gus.

"This here's a mighty good car," Doc went on. "But two weeks after I got it, it quit charging. My brother-in-law swore it never did that before, but I had to have the generator overhauled."

"Mean to say you've got charging trouble, too?" asked Gus, taken aback.

"What d'you mean, 'too'? Haven't got any other—isn't one enough?"

"Sure, sure. Go on," urged Gus.

"Three weeks after, it quit charging again. Mechanic out west said the commutator was oil-fouled. Rubbish—the car doesn't lose any oil. But he got it working—till it quit yesterday."

"I'll check it out," promised Gus.

"Not a word to Dave, huh?"

"Drive the car around back," returned Gus, "and he'll never know."

LEAVING Stan, his helper, to remove Rankin's generator, Gus checked the fan belt, battery terminals, and charging circuit on Doc's car. All were sound. The battery was low enough to take a

hefty charging rate, but a test meter showed nothing coming through, even with the regulator's field terminal grounded.

Disconnecting the generator lead, Gus scratched it on the block. There was no spark. With the engine off, he felt the commutator through an opening in the generator housing. It was oily.

Gus removed the generator and opened it on the bench. Commutator and brushes were oil-fouled—a strange thing since this generator had no oil cup. He cleaned the parts with car-

bon tet and found brushes and springs in good condition. Reassembled and run on the test block, the generator charged normally.

Leaving Stan to re-install it on Doc's car, Gus turned to Rankin's generator. Outside, it was thick with oily dirt but, to his amazement, the internal parts were clean and in good order. When belted to the bench rig, Rankin's generator charged steadily.

Gus rubbed his nose with a knuckle.

One generator, from a clean engine, had an oil-soaked commutator. Another from an engine covered with greasy dirt worked fine—when not in the car.

Putting Rankin's generator back on, Gus made an instrument check; the test meter flickered like the ammeter. As he disconnected it, something splashed against his cheek.

It was oil, perhaps flung up by the swirling fan stream. Gus frowned thought-

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fully. The oil leak Rankin chose to ignore annoyed him. But what could it have to do with the charging circuit?

He got down on a crawler with a drop light and slid under the car. The bottom of the engine was encrusted with oily muck. It looked cleanest under the front main bearing, where oil was probably leaking past a bad seal. The crankcase seemed oddly atilt, low in front. Flashing the light on the engine mounts showed fragments of oil-rotted rubber clinging to one. The others lacked even that much of the pads meant to cushion the engine.

Gus rolled out and stood up, staring down at the forward-slanted engine. Then he leaned far over at the back of the engine block. Between the canted engine and the fire-wall, the braided bonding cable was stretched tautly, all but a few strands torn free.

Stan spoke suddenly at Gus's elbow: "That generator I put on charges fine."

"Thought it would," grunted Gus. He pointed to the almost severed strap. "There's the intermittent ground in this one. Vibration probably grounded the block now and then through the metal parts of the engine mounts, so it charged part time. Put on a new bonding cable, Stan."

JUST as Gus had his pipe going nicely, Doc Hockenjoss returned. The lanky veterinarian raised skeptical eyebrows over Gus's account of the trouble.

"It *can't* be oil on the commutator. Nobody's put oil in this engine since the generator was last cleaned."

"You sure of that?" asked Gus.

"You bet. Nobody checks the oil but me. I like to do it with the engine cold, to get the true level."

"You try to oil the generator?"

"Quit kidding, Gus. You know that

there's a sealed bearing in that one."

"Okay," said Gus. He hung a clean rag over the open generator slots. "Now show me just how you check the oil."

"What's to show?" grumbled Doc. He grasped the dipstick, which stuck up a few inches behind the generator. "I pull this up, slant it forward to get it past this whopping air filter that's in the way, and take it out."

He held up the oily dipstick, then shoved it back in with a snort. Gus lifted the rag off the generator and spread it out. On it were two oil spots.

"That's it," nodded Gus. "Under that big air cleaner, you never saw it happen. But every time you checked the oil the dipstick dripped on or near the commutator. A good service-station man holds a rag under the dipstick."

Doc stared. "Gus, you won't . . ."

"When you doctor one horse, do you tell another?" asked Gus.

A WEEK later, as Gus was finishing a big dinner, Rankin and Doc walked into the Okay Diner.

"Have a good trip?" asked Gus.

"Swell fishing," said Rankin. "But our bet turned out a draw."

Hockenjoss nodded. "Neither of us had any car trouble, thanks to you."

Rankin's plump face split in a grin. "Yeah, we told each other, Gus. I'd like those engine mounts fixed now."

"Any time," said Gus. He stood up, stretched, and walked to the door.

"Hey, Tom," boomed Doc. "Doesn't Gus have to pay any more?"

The counter man shook his head. "We bet, too. He won a week's free meals."

"A bet? On what?" asked Rankin.

Gus grinned from beside the door. "A sure thing. After you made your bet, I gave Tom two to one you'd both bring your cars in before you left." ■ ■

Where'd it come from?



Why "portside" when you mean the left side of a boat? This goes back to the Vikings, who docked their ships with the left side against the dock when in port. That way, they avoided damaging the rudder or "steering board" which was usually on the right—hence "starboard"—side.

And did you know that the word "posh," meaning elegant, comes from the way luggage was marked on steamships outward bound from England to Asia? The deluxe way to travel was in a cabin facing "Port Outwards, Starboard Home."



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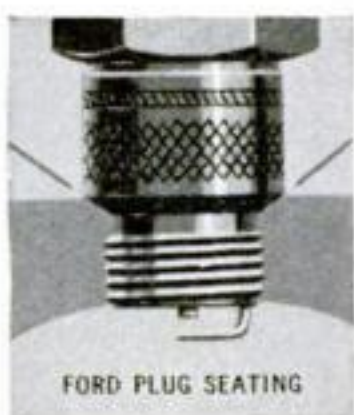
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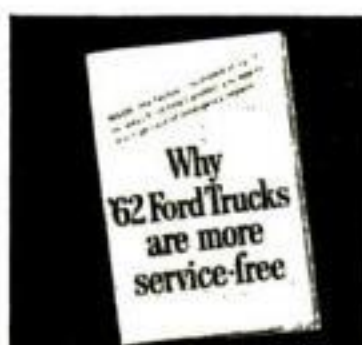
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What You Should Know About Fallout Meters

[Continued from page 89]



DELUXE MODEL FOR HOME OWNERS is this Lionel rig with Geiger tubes mounted on the ends of cables. They detect radiation around house, feed information to meter inside a shelter.

(turning the knob to "check" should make the pointer swing). Then you set the pointer to zero (there's a knob on the Bendix and Victoreen instruments; Lionel's zeroes itself automatically). Now you're in business. You read radiation off the meter, which looks like a speedometer dial.

The fallout shelter itself would be surveyed for leaks. Individual dose records would be kept up. Gingerly poking the meter out the shelter entry—and later outside the house door—would reveal when it was safe to leave shelter, and for how long.

Some people forget that radiation meters are measuring instruments, not shielding amulets. They won't protect you one bit against radiation. All they can do is substitute for a missing human sense—they say "ouch" for you. You still have to decide what to do after the meter tells you that you're hurting.

How Good Are They?

The meters described here have been (or are about to be) "accepted" as meeting standards set by the U. S. Office of Civil Defense. Others may be accepted

in the future, although OCD reports that manufacturers are not rushing to submit their products for testing.

The official requirements are stiff. A civilian meter must be small, light, almost unbreakable, simple enough for your wife to use and your TV man to repair, and fairly accurate (plus or minus about 25 percent) even after you have fished it out of a puddle. It must indicate radiation with a pointer on a meter—changing colors, audible tones, or clicks are not allowed. And it must register gamma rays only.

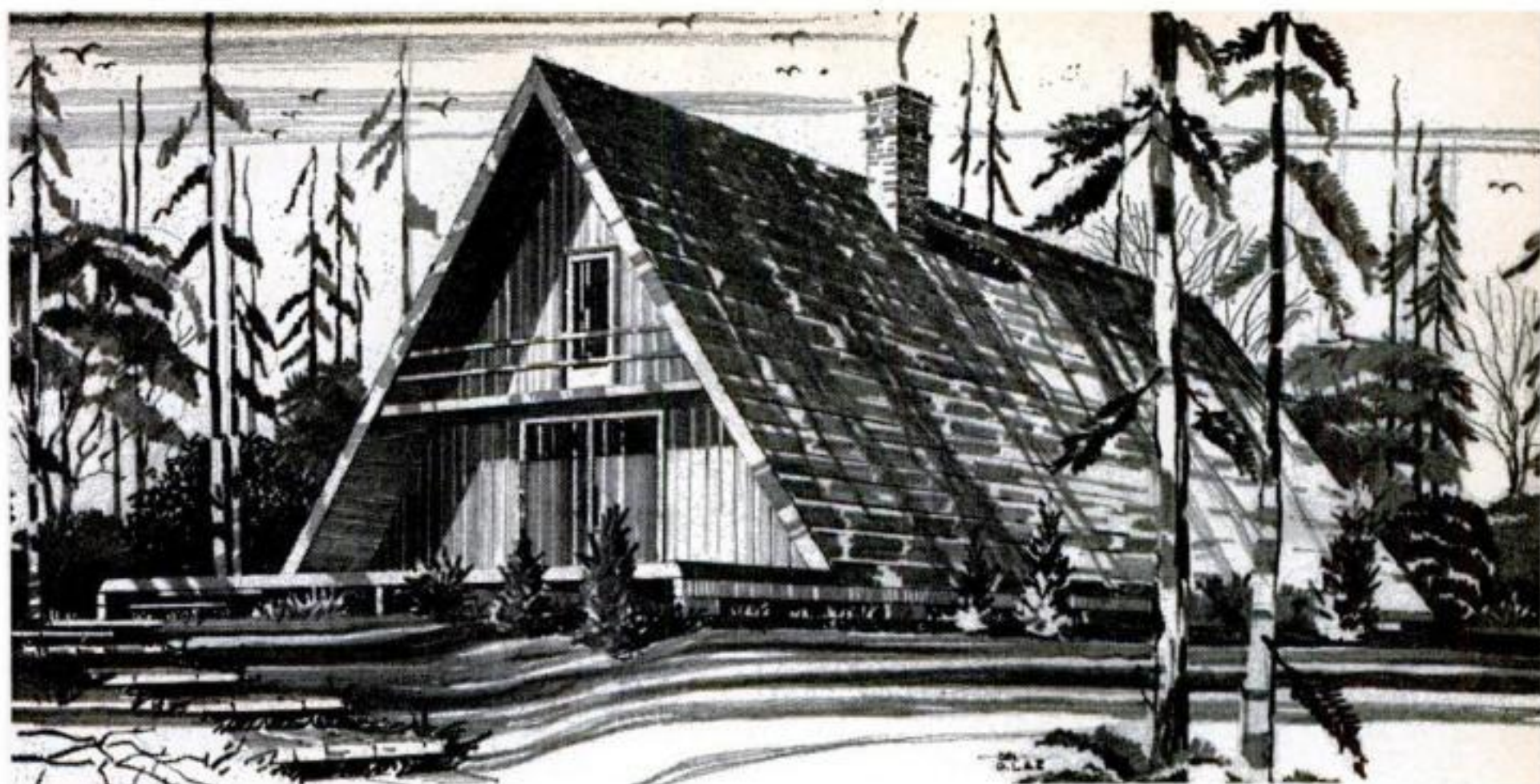
This last requirement rules out some professional survey meters that the government buys for local civil-defense teams. Many of these detect both gamma and beta rays. Fallout will give off both, but the beta rays seem to be a lesser hazard.

They don't penetrate, so they cannot cause much harm unless the hot dust is right on your skin or inside your body. The pros need to know if field crops are contaminated with beta emitters—such food would be dangerous if eaten unwashed. Ordinary home owners wouldn't have to worry much about that, and might be confused if their meters were sensitive to both types of radiation.

The Price Tag

Toughest of the official specs, however, is price. OCD is shooting for \$15 wholesale. So far only Bendix comes close to that target, but it does prevent "acceptance" of good, though high-cost, meters already on the market. Retail prices are: Bendix \$25, Lionel \$40, Victoreen \$50. The Lionel and Victoreen instruments are new, but should be on sale this year.

There's no law that says you have to limit yourself to the accepted meters. You'll find some gadgets for as little as \$3.98 (OCD takes a dim view of them as dangerously inadequate). Or you can blow \$100 on a fancy Lionel rig that indicates radiation by remote control—sitting safely inside a shelter, you could monitor levels at several locations outside. The accepted meters are in the middle. They do the job that the government considers essential, but no more than that. ■ ■



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What Happens When You Call the Cops?

[Continued from page 103]

cluding license number. Summoned by an amber light on the console, a messenger carries a copy of this to the point-by-point operator. Three buzzes echo through the communications center; zone dispatchers notify all cars to stand by, and the point-by-point man relays the "wanted" message to city cars, then to stations outside Chicago.

The manhunt is on. Now some 500 cars—as well as units in surrounding territory—are on alert for the desperate trio. A full-scale manhunt swings into action.

At his console, the zone dispatcher handling your report now presses another switchboard button. This signals the "hot desk," elsewhere in headquarters, which informs him that the license number of the getaway Olds is on the department's stolen-auto list.

By the time the dispatcher has added the hot-desk information to his original lookout message, word has reached a dispatcher for another zone that the fleeing car has been sighted. One squad already is pursuing, but the thieves' zigzag pattern indicates that they hope to elude, rather than outrun, the cops. It's time for strategy—and still another communications facility.

Plotting the chase. By intercom, word is flashed to a supervising sergeant. On the sergeant's order, one of the city-wide dispatchers leaves his console and joins the sergeant in front of an 8-by-12-foot, metal-board map of Chicago's 224 square miles, complete with magnetized colored disks that can be moved about to represent cars. The two officers now take command of the chase, broadcasting on a city-wide frequency that allows every mobilized policeman in the city to know if the fleeing men head his way. One man listens to reports from the police cars, and his partner sends commands. Moving numbered disks (a black one for the Olds, others for police cars), they chart the path of the chase and plot deployment of pursuing vehicles.

Presently, an officer radios that he is hot on the tail of the fleeing car. "Give me the mobile relay," he asks. A button is pressed, and the policeman is able to radio directly to all other cars.

The capture. In moments that seem like hours, the pursuing man commands

a motorized assault on the stolen Olds. From all sides, police cars converge. Finally, the gunmen find all avenues of escape blocked. Their car shudders to a halt, and policemen close in.

Back at the communications center, the lookout message is canceled by point-to-point; the hot desk is notified of the stolen auto's recovery; and your complaint card is taken from the slot at the zone console, time-stamped again, micro-filmed, and given a permanent number. When the officer who originally responded to your call recovers from his wounds and files a report, it will bear the same number as the complaint card.

By then your report of a theft-in-progress will have run the gamut of the fastest and most comprehensive police-communications system in existence. ■ ■

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A plastic TV mast atop Norway's mile-high Tronfjeld Mountain carries a heavy coat of ice in near-arctic weather. Reinforced fiber-glass walls are just a quarter-inch thick, but the top of the 80-foot tower has bent only eight inches in a 157-m.p.h. hurricane. Aerial is accessible from within even in the worst weather.

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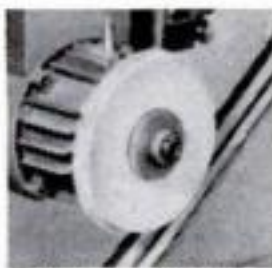
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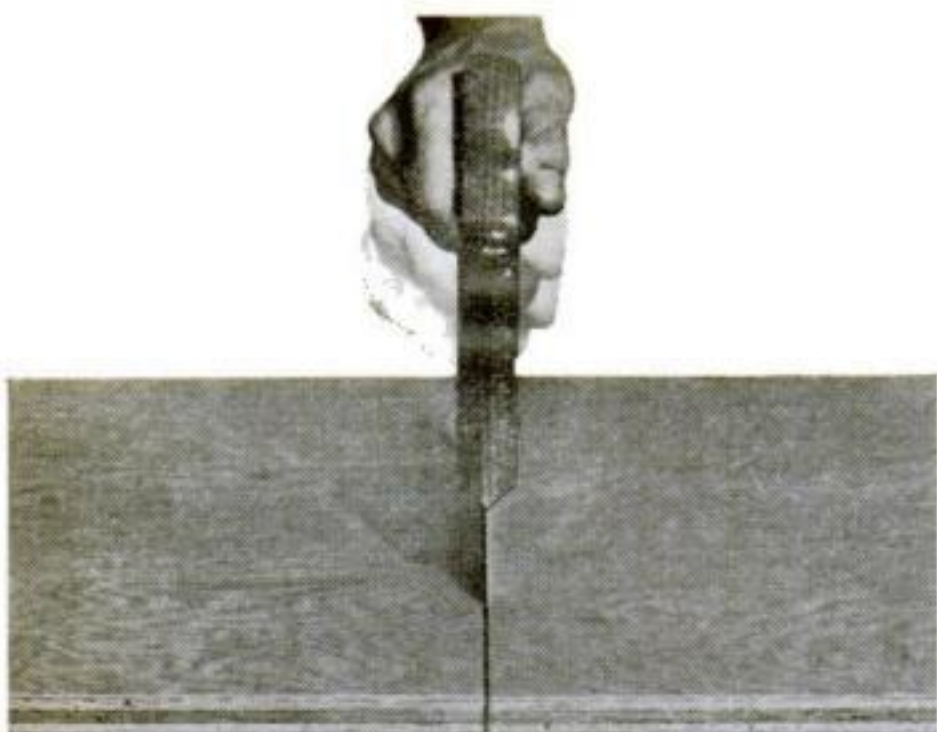
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**DISSTON DIVISION
H. K. PORTER COMPANY, INC.**

Shooting Telephotos with Binoculars

[Continued from page 195]

those taken with an actual telephoto lens.

The beauty of the binoculars is that they serve double duty on a picture-taking jaunt. Twist a single screw and your glasses are uncoupled, ready for long-range spotting.

How powerful your camera-binocular combination is will depend on the focal length of your camera lens and the power of your binoculars. Multiply the camera-lens focal length (engraved on the lens ring) by the power of the binoculars. Suppose your camera has a 50-mm. lens and your binoculars are 7x50s (7 power, 50-mm.-diameter objective lenses). You would have the equivalent of a 350-mm. telephoto lens.

Single-lens cameras are easy to focus because you see through the viewer exactly what the film sees. Non-reflex cameras should be test-focused and marked for different known distances to get sharp pictures at less than about 100 feet. To avoid chopping the corners of pictures, binoculars should be at least 6x30s and have a lens focal length of not less than about 48 mm.

How to take bino-photos. The powerful magnification of your combination also magnifies the slightest movement, causing blur. Use a tripod to keep the camera rock-steady.

Exposure through binocs is different—actually the reverse of the usual procedure where you select a shutter speed and then stop down the aperture to suit the light and film speed. This is because the camera lens must be left wide open to prevent under-exposing the corners of the film. Exposure is varied by changing shutter speed only.

Forget your original lens openings. To calculate exposures now, you use one fixed *f*-number. Here's how you can find it. Multiply the binoculars' power by the camera-lens focal length. Then divide this by the binoculars' objective diameter. The result is effective *f*-number. Using 7x50 binoculars with a 55-mm. camera lens, the fixed *f*-number would be about *f*/7.7. The actual diameter of the objective aperture does not always match the engraved number on some binoculars. Treat the *f*-number as a guide for exposure and shoot several shots of one subject using different speeds.

Color bino-photos may be incorrect color-wise because of slightly tinted lenses in the binoculars. Shoot both regular and binocular photos on the same film to check their color quality. ■ ■



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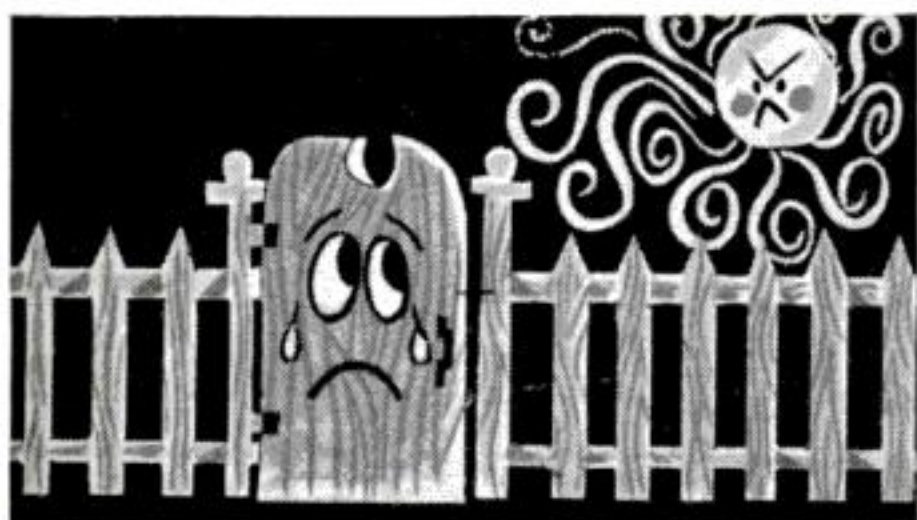
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Products of United States Plywood



The New Compact Tools

[Continued from page 146]

jointed surface was better than the mill-finished one.

Milled grooves on the underside, over 3/32" deep, were removed in two passes requiring 122 seconds on a 3' length. To joint the grooved edge flat (removing 9/32" of hardwood) took 48 seconds. A rugged 1/4"-deep cut on knotty spruce, taken slowly, left a good surface even on the knots.

The rear table is fixed. The front one lowers to a maximum cutting depth of 1/4". Its adjustment was stiff.

A depth gauge, visible from the top of the table, is designed to eliminate the usual neck-craning to see underneath. But, while good in theory, it has a shortcoming: The scale catches piles of chips and isn't readable unless you keep scooping them out. The 2"-high fence needs a wider, auxiliary fence for edge-jointing boards more than 5" wide.

On the plus side are lifetime-lubricated ball bearings, knives that lock automatically in line with each other, and a screw adjustment for setting the cutter head level and parallel with the rear table. The fence tilts either way to 45 degrees. It has a big, legible scale and an effective lock knob. A second knob locks it on the table, where it can be shifted without altering the tilt.

Both the saw and jointer make chips in such great quantities that they'll clog inside the housings if not cleared frequently. A method of mounting the machines on cutout boards to let the chips drop through is shown in a sketch.

Trying the drill press. Drilling to 1/2" diameter in steel and 1 1/2" diameter in hardwood is just about maximum effort for this tool. This is perfectly adequate for average home-shop work, but it's a little short of a big drill press.

The small base—8" by 11 3/8"—has the effect of making the Rockwell a bit top-heavy. This can't be helped if you're going to be compact, but it does mean that rigid mounting, at least on a board, is advisable. The machine has a dual-splined spindle with a ball thrust bearing and a 1/2"-capacity geared chuck. It can drill to the center of a 10 1/2" circle.

Stepped pulleys give you a choice of 800, 1,750, and 4,000 r.p.m. For sensitive drilling, return-spring tension can

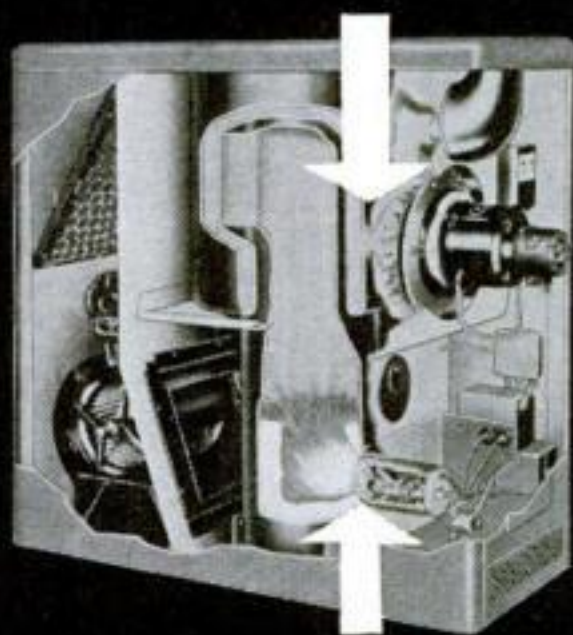
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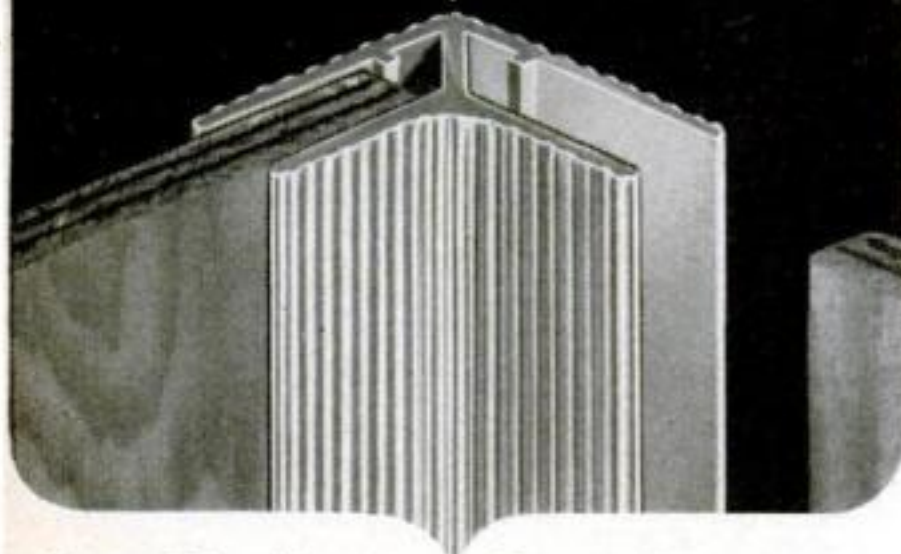
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The New Compact Tools

be adjusted. Spindle travel is 3". The depth stop is set by rotating a collar against a circular depth gauge.

The table slots proved too small to admit even a 2" C clamp. You'd need bolts to clamp work close to the drill. Side clamping ledges on the table are handy for larger work, but they don't make up for skimpy slots.

A level test made on the table with a dial indicator swung on a 5" circle showed .013" side tilt (about 9 minutes of arc). This isn't enough to bother a woodworker, but may not satisfy a machinist.

Somebody goofed. The quill and table-lock handles are mere flattened ends, too short and sharp cornered to give fingers good leverage. Worse, the table lock tightened finger-pinchingly close to the sharp rear table edge.

At 800 r.p.m., a 1" spade bit fed hard into $13/16$ " maple went through in $9\frac{4}{5}$ seconds. This was the only test in which the drive faltered—the chuck skipped and stopped sporadically, suggesting a flutter in the motor mount. My conventional larger drill press made the same hole in five seconds.

The Rockwell did better in metal. At 1,750 r.p.m., it pushed a $\frac{1}{4}$ " high-speed twist drill through $\frac{1}{4}$ " aluminum in 4 seconds, through $\frac{3}{8}$ " mild steel in $8\frac{3}{4}$. At 800 r.p.m., a $\frac{1}{2}$ " twist drill chewed through $\frac{3}{8}$ " steel in 34 seconds.

This last rugged test was repeated four times. Then the table was again checked with the dial indicator. It showed no sign of being sprung—alignment was still just .013" out.

What are they good for? Despite the drawbacks noted, these are capable tools. They can't be expected to duplicate the work of machines costing two or three times as much—and they don't. Those who are super-economy minded may wince a bit at the thought of buying three motors instead of one.

But the machines will handle anything that the average home-shop craftsman is likely to ask of them. And consider Rockwell's original aim—to produce tools that can be used anywhere, any time, simply by setting them down and plugging them in. In this, surely, these small machines have come up a winner. ■ ■

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What'll It Be Like in 2000 A.D.?

[Continued from page 87]



A BOOK-SIZE COLOR-TV SET with stereophonic radio and clock timer is among the forthcoming electronic pleasures prophesied by RCA in its exhibit at the World's Fair in Seattle.

Seattle Fair forecasting future wonders.

The American Library Association, for instance, shows students of 2000 A.D. tapping foreign languages for extra knowledge even when they can't read a word of them. Electronic translating machines instantly convert any foreign text into English. Also, at the twist of a dial, computers spew out complete lists of reference books on any subject. And if you want to take a look at a rare picture or manuscript in some distant library, you can do so by closed-circuit TV.

OUT in tomorrow's tall timber, the Society of American Foresters portrays land managers injecting dyes into growing trees. Result: colored wood to suit any popular fancy. The same technique—inserting hypodermic needles into living trees—will inject growth stimulants, insecticides, disease-killers, or radioactive tracers to reveal where a tree's roots lie.

Another development that the American Foresters expect in the 21st Century is the wide use of helicopters in lumbering in place of tractors and trucks. This, they say, will spare forest seed beds a lot of the churning up and erosion they now suffer, and thus increase and improve our future timber crop. ■ ■

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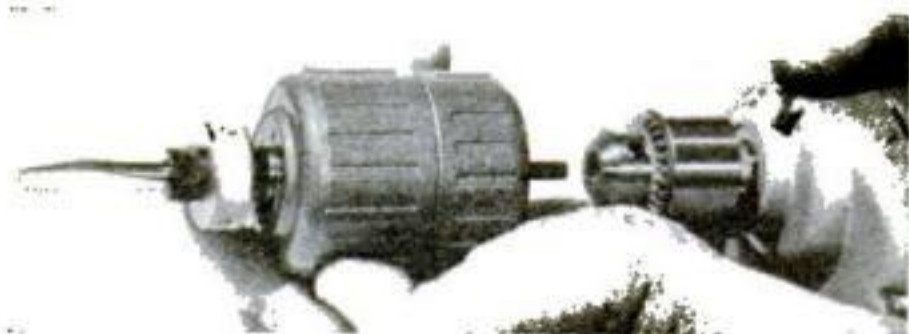


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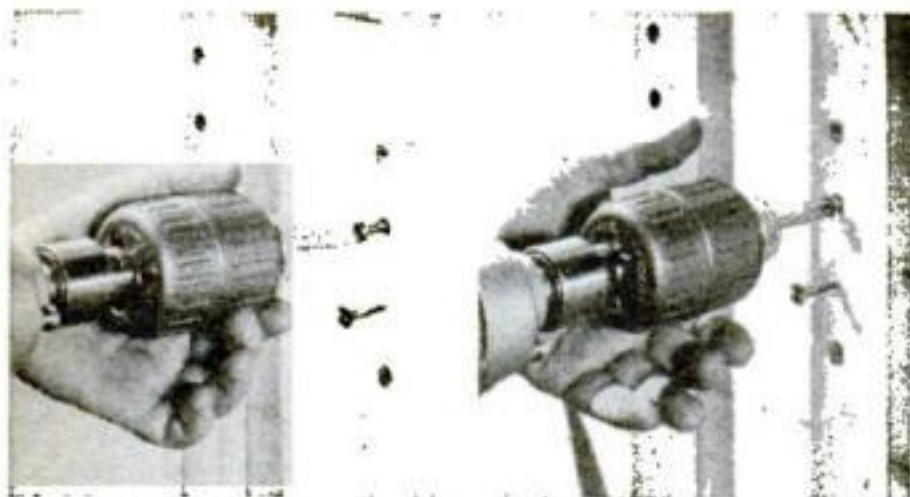
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Kidnapped Locomotive to Ride Again

[Continued from page 112]

old locomotive today would be almost a desecration. So they've wisely let sleeping dogs lie. The big job was to get her off the display shelf, tuned up, and running like her old self.

Fun job for a locomotive shop. In the huge Louisville shops of the L&N these days, they're busy on diesels. But there are still plenty of nut-splitters who know how to peen a rivet or set valve-gear eccentrics to favor forward running. The General's Russia-iron jacket was carefully removed, followed by the lagging (wood insulation). The boiler underneath was sandblasted and found to be in topnotch condition. Only the fire tubes and the stay bolts—reinforcing studs that held the outer and inner firebox walls apart—had to be replaced. An ancient steam gauge, embossed "W&A," was tested. At the General's 140-pound operating pressure, the gauge still gave an accurate reading.

Some concessions had to be made for safe and practical engine running. The General as she stood would have needed two tenderfuls of coal or three of wood to get her over the 87 miles between Kennesaw and Ringgold, Ga. To eliminate refueling, an oil burner was placed in her firebox and a 600-gallon fuel tank was tucked in her tender. Because there are no longer any water columns along this part of the Dixie Line, local fire departments will cooperate on the day of the Commemorative Run.

Another problem was feeding water into the boiler. Like other early locomotives, the General had two pumps, worked by the action of her piston rods. This was fine while she was in motion. But if the level dropped dangerously low during a prolonged stop and she couldn't be moved, you had two choices: dump the fire or tie down the engine and grease the rails under her driving wheels. That way, her cylinders could be worked to activate the pumps. Installing an injector, which squirts water into the boiler at the twist of a valve, has eliminated that worry.

Brakes—another headache. To stop the General, there were only four shoes that dragged against the wheels of her rear tender truck when the fireman cranked a handwheel. For quick stops,

Kidnapped Locomotive to Ride the Rails Again

her engineer could only reverse the locomotive. This rough treatment failed now and then, when back pressure blew out a cylinder head. To meet the requirements of the Federal Bureau of Locomotive Inspection, automatic air brakes have been added.

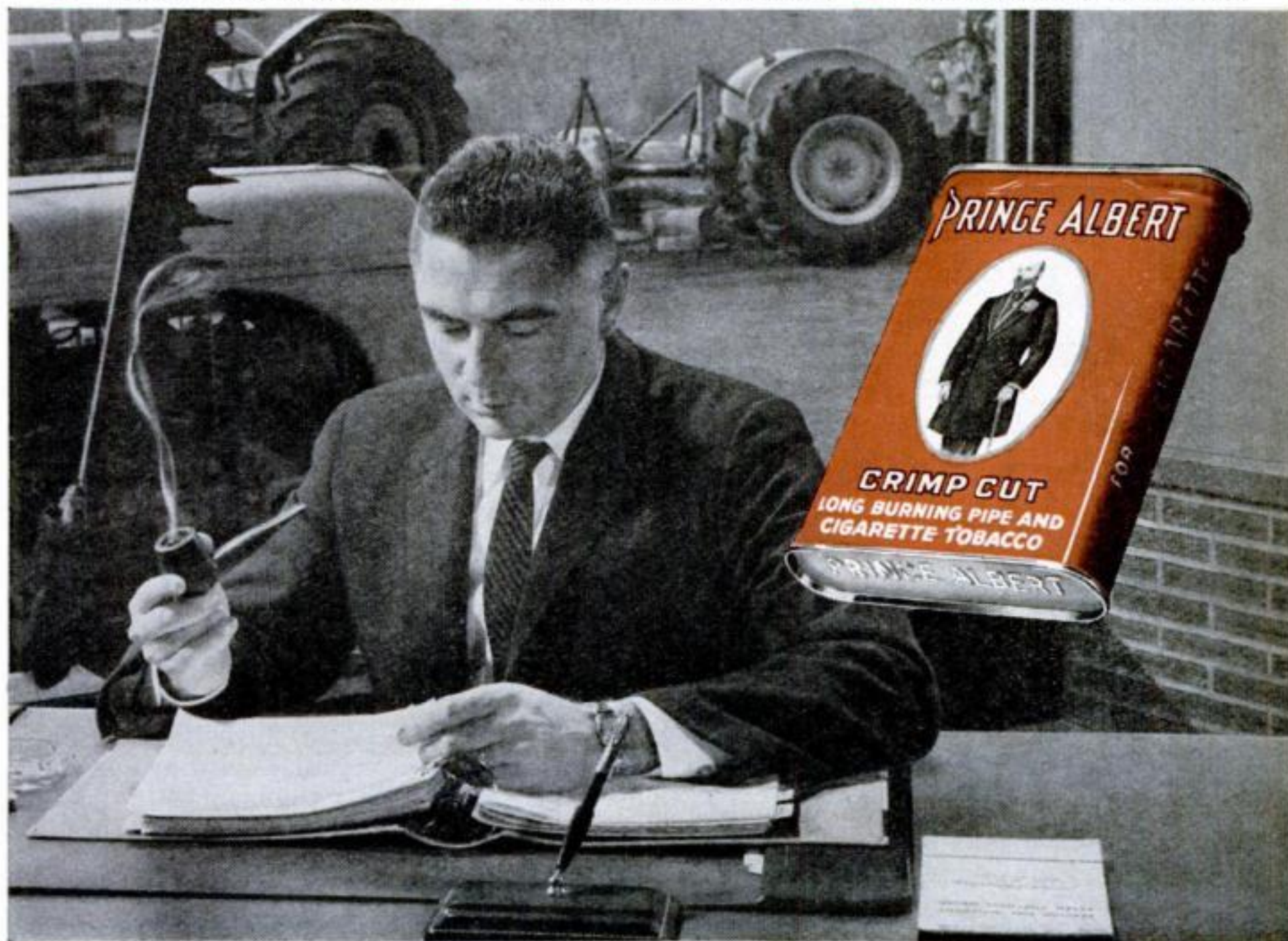
The L&N didn't have to look far for an authentic coach to trail the General. The line borrowed back an old combine—one used in the movie *Raintree County*—that they had given to the Kentucky Railway Museum. Its red plush seats

have been elegantly re-upholstered, and other furnishings, including oil lamps and Baker heaters, refurbished. An aisle has been left in the central baggage section. On one side, dioramas will illustrate highlights of the Andrews raid. On the other will be modern L&N exhibits.

In addition to the main event of April 14th, the locomotive and coach have been offered for display in all of the 13 states the railroad serves. It is already booked solid for five months—one old general that didn't fade away. ■ ■

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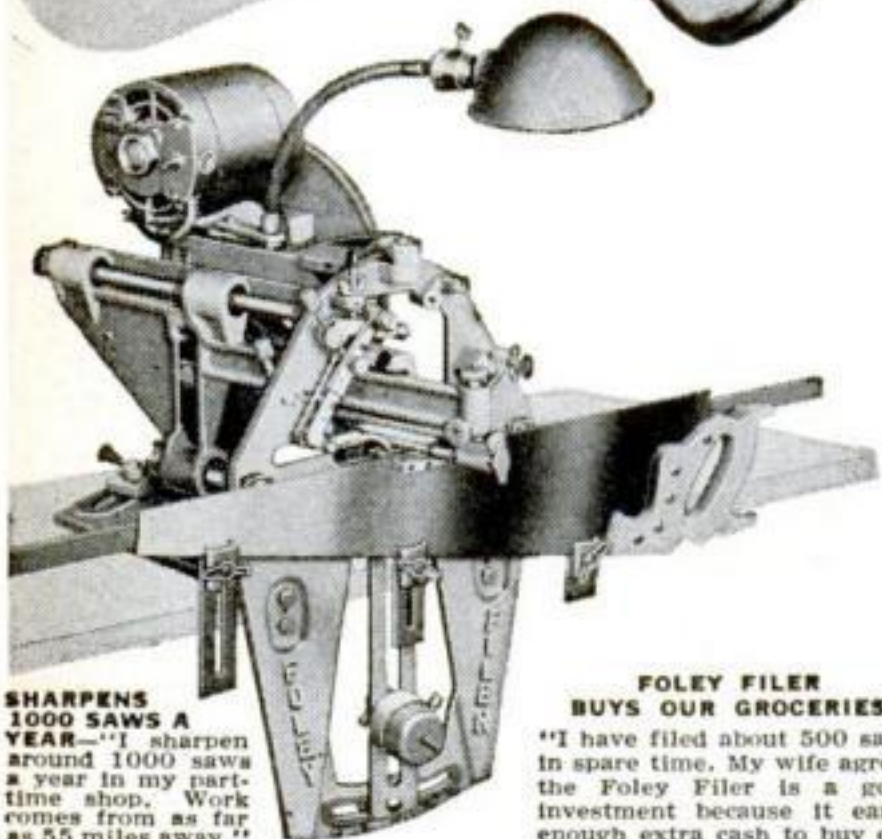
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The Marvelous March of the Microwaves

[Continued from page 83]

ways," which when complete may rival that of AT&T, has just been launched by Western Union. As a first step, the company is setting up a chain of 236 relay stations 5,300 miles long with 600 voice channels that can carry 2,400,000 words a minute between Boston and Los Angeles, and cities along the way. Stations are being installed so that carrying capacity can be increased to nearly 1,000,000,000 words a minute, if used entirely for voice transmission. But such channels are usually shared by several types of communication such as television, telegraph, facsimile, and computer data. Western Union plans to expand the system until the entire country is cross-hatched with its narrow pencils of waves some two inches long.

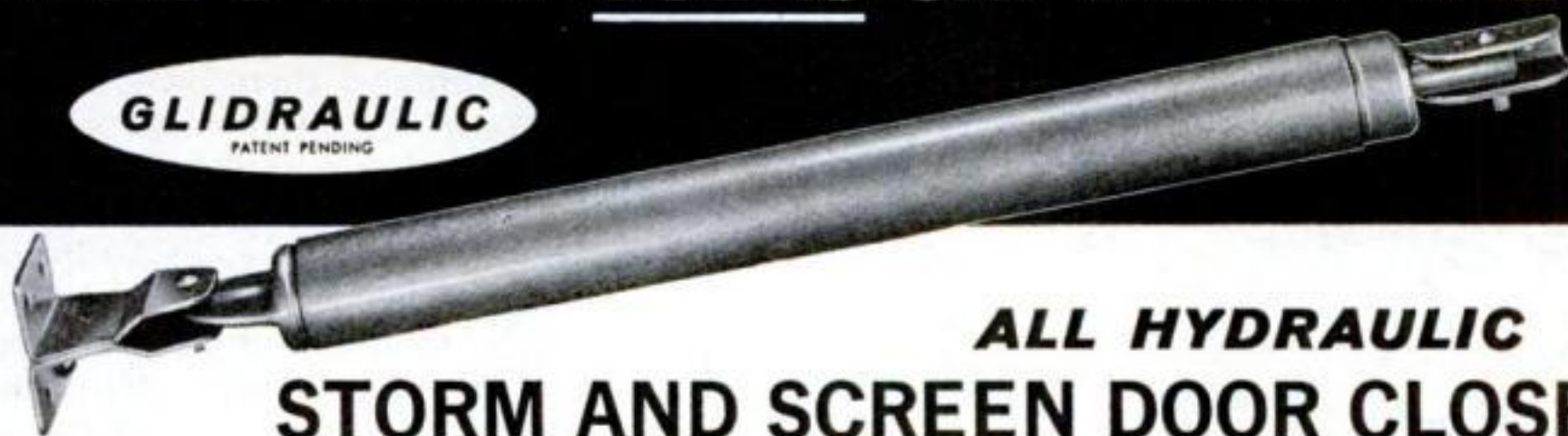
Planning the route. The rapid growth of microwave has created a crazy-quilt pattern of radio beams causing considerable confusion, and has created the new engineering specialty of microwave route surveying. Such surveyors must not only cope with mountains and valleys, but with the invisible radio barriers of existing systems that may block their beams. When Western Union launched its system, it called in Victor J. Nexon, president of Microwave Services, Inc., of Denville, N. J., to survey the terrain and select a route. It has taken a crew of 80 men two years to do the job. Riding in everything from helicopters to snowcats, climbing snake-infested slopes and sweltering in desert heat, they first made a surface survey, tentatively marking desirable station sites so that they could be spotted from the air. Then airplanes made overlapping stereo photographic shots of the entire route, furnishing data for contour maps accurate within a few feet of altitude. After that came the actual purchase of sites and the construction of the relay stations.

Sometimes surveyors use searchlights at night to test transmissions between two relay-station sites. If the beam of light encounters no obstacles, the microwaves will get through. When microwaves pass over water or flat desert sands, their reflection may foul up transmission, requiring readjustment of the beam. Once engineers could not account for poor reception in a mountain-top

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The Marvelous March of the Microwaves station; then they found that squirrels had stored acorns in the wave guide.

There are hundreds of smaller microwave systems, some of them only a few miles long. Many TV studios use microwaves to beam their programs to out-of-town transmitters, saving the cost and trouble of laying cable through built-up areas. A New Orleans station planned such a hookup, then found that a new bridge would block the beam. RCA engineers found that the line-of-sight beam could be sent beneath the bridge, and all was well.

For highway control. Many big toll highways have installed microwave systems for police and administrative communication. Microwave beams over the New Jersey Turnpike permit remote control of warning signs in case of fog or sleet, and on the Illinois Turnpike, toll payments are automatically recorded at each booth, and the totals transmitted at intervals by microwave to a central computer. In many such systems, microwaves are used for the long hops, and messages are converted at the relay stations to lower frequencies for radio-telephone communication with police cars and other vehicles. Such a mixture of air waves now maintains a spiderweb of police radio-telephone communication over the city of Philadelphia. Four microwave dishes at the base of William Penn's statue on City Hall beam signals to regional headquarters for conversion to police-car frequencies, while above them, inserted in the bronze head of the Founding Father, inconspicuous "hat pins" serve as antennas for the central area.

Hundreds of microwave systems have also been installed by private firms, where they are of particular value to railroads and oil and gas pipe lines. The beams are now relayed along some 8,000 miles of U. S. railroad track, where they control switches and signals, regulate electric power flow, and transmit business messages. Refiners use them to regulate the flow of piped gasoline and fuel oil, turning valves by remote control to divert oil to different areas according to need. By means of microwave impulses, engines, pumps, and other machines in unmanned stations miles away over water or rough terrain

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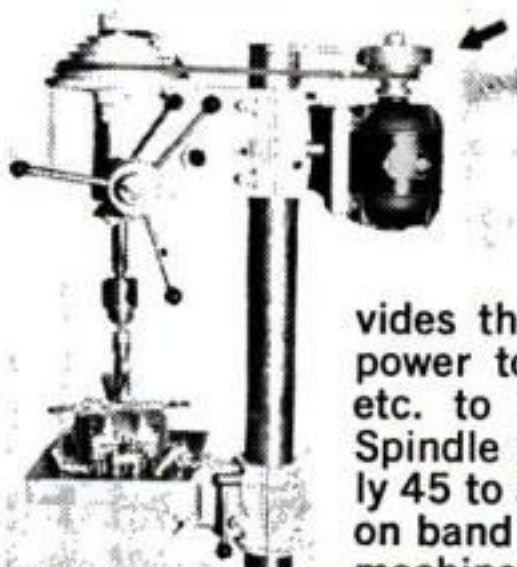
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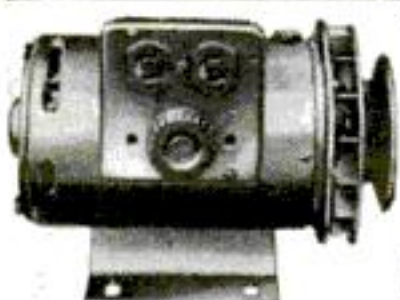
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The Marvelous March of the Microwaves

can be turned on and off, and will signal the home office when they have trouble. Two years ago the Federal Communications Commission opened microwave channels to all private businesses, and the use of these small networks, which operate in a separate wave band, is soaring. They cannot carry the traffic load handled by the big microwave arteries; by comparison they are country lanes. In many cases they will serve as cost yardsticks in competition with big communications firms.

In the Los Angeles basin, five divisions of North American Aviation, some of them out of sight from each other, are connected by microwave network by means of a relay station on 3,750-foot Oat Mountain, which they all can "see." When a rocket engine is test-fired, the performance data, recorded on magnetic tape, is now relayed to a distant computer. The test is analyzed and the results beamed back. This means that the second test can take place in 45 minutes instead of several hours later.

Spanning the jungles. Microwave networks are especially attractive to undeveloped countries. Just as the airplane has leapfrogged over primitive surface transport in South America, Asia, and Africa, microwave beams are now spanning jungle and desert where telephone lines and telegraph wires would be impractical or even impossible. Brazil's new inland capital city of Brasilia is connected with other centers by microwaves that hop over forests and mountains. Colombia's communications system depends on more than 100,000 channel miles of microwave, with some relay stations located on 12,000-foot peaks. In inland Pakistan, wide rivers, monsoons, and floods once made land-line communication impossible. Now a microwave network installed by RCA provides nationwide phone and telegraph service for 43,000,000 people living in East Pakistan and adjacent areas.

Isolated nations still in the oxcart stage are planning new networks, and simpler, inexpensive systems are being devised for such needs. At a recent meeting of Asian radio men in Tokyo, H. E. Weppeler, AT&T radio engineer, described one such "poor man's" microwave system developed by his company.

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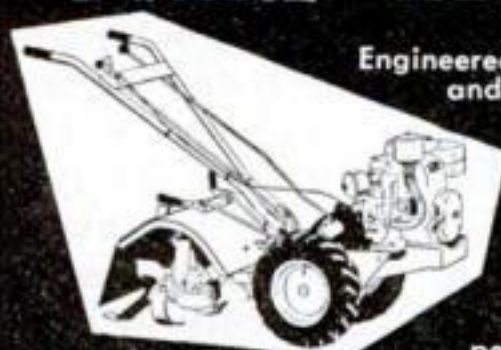
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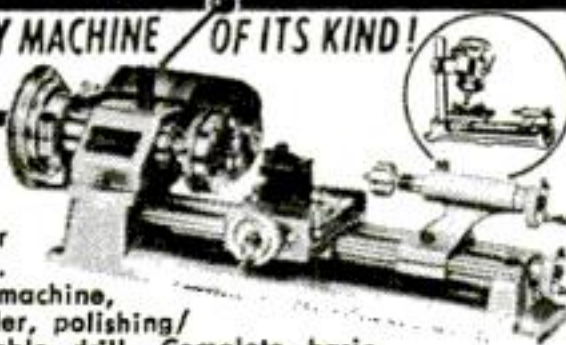
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The Marvelous March of the Microwaves

The antenna, he explained, could be mounted on wooden telephone poles, no buildings would be needed, and the routes could follow accessible roads and rivers. Such a route could carry from 25 to 200 phone calls at once, and could be installed by local telephone linemen without outside help.

Meanwhile, in the big industrial countries, greatly increased trunk-line capacity will be needed to carry the volume of words, pictures, and figures projected for the years to come. One item, Bell System toll messages, increased 64 percent over the decade ending in 1960. Computers are still in their infancy, and these proliferating giants will become as loquacious as party-line housewives as they assume an increasing burden of man's mental drudgery. It is estimated that the entire American electronic communications system will have to be doubled in the next 10 years, and redoubled every decade after that, as far as the mind can reel.

Tinier waves, too? New channels may be found for the rising river of messages by opening still more virgin terrain in the upper reaches of the electromagnetic spectrum between today's microwaves and the visible light band. This region, where frequencies run in the hundreds of billions and waves are a fraction of an inch long, is now little better known than the Western Hemisphere when Columbus set sail. Harnessing these waves presents serious problems in equipment design. Scientists are exploring them in a score of laboratories, and many believe that they offer promise of broad new avenues of communication in another 10 or 15 years.

Farther ahead lies the possibility of radio transmission by a new kind of light. For many years, scientists have experimented sending messages by modulated light beams, but such transmission has been clumsy and ineffectual. It seemed impossible to "tune" light to obtain a narrow, coherent beam, as can be done with radio waves.

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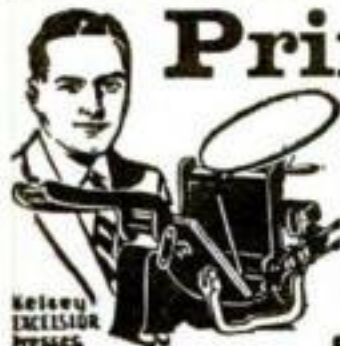


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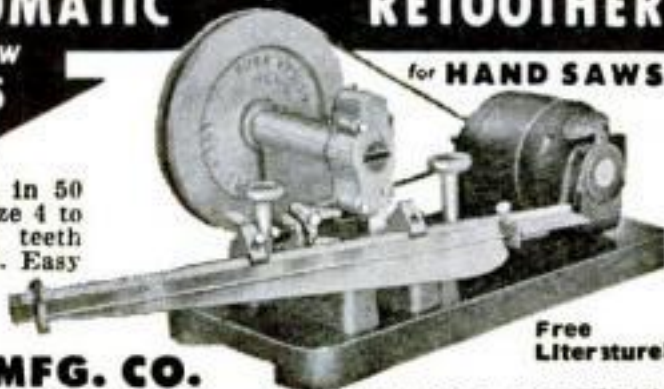
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Whatever methods are adopted, it seems likely that in a few years waves less than an inch long will be carrying much of man's oral and pictorial messages across the world's continents. Nor will microwaves stop at the seashores. Several relay satellites will be shot up this year as a first step toward the establishment of a worldwide network for carrying phone calls and TV across the oceans. It will take years to solve all the technical and political problems, but if enough phone users want direct dialing to all the world's telephones, engineers can arrange it. And if some day we wish to talk with men on the moon, existing microwave systems can handle the job. ■ ■

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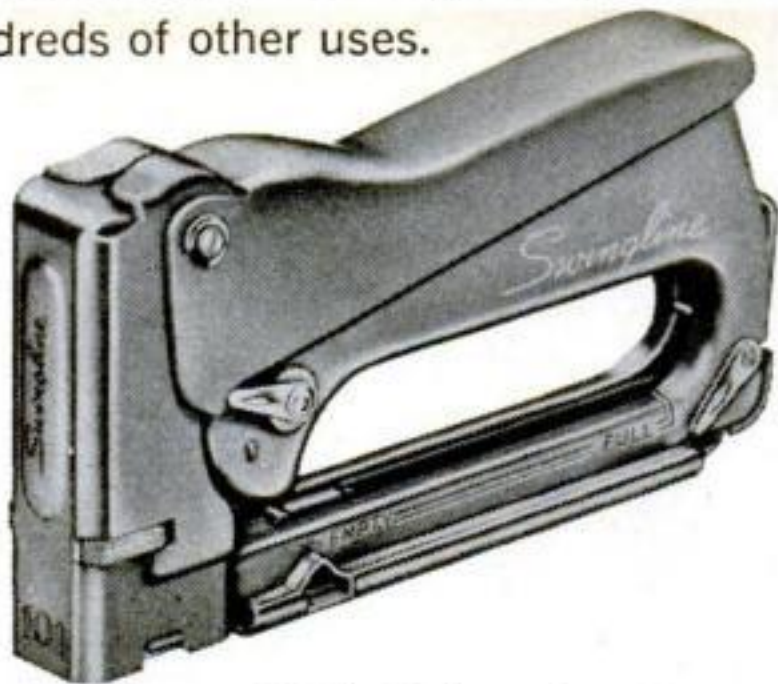
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Exploring the "Moon" by Jeep

[Continued from page 140]

have special need for waterless cement.

A lava cave. We stumbled and crawled across another quarter-mile of jagged lava fragments to a surprisingly large cave. It had been formed in the process of flow and cooling. We estimated that it was about 60 feet deep, 40 feet wide, and 10-20 feet high.

"Lava caves and tubes are quite common in lava fields," Green told me. "I've explored many of them and have even slept in a few."

"If, as I believe, the moon is dominantly volcanic, a lunar explorer ought to find plenty of places like this in which to take shelter from radiation and micrometeorite bombardment."

"How could he heat it?" I asked.

"He could do it with mirrors, arranged to reflect sunlight inside," Green suggested. "Or he might use thermal rods, driven through the roof. The exposed ends would become very hot, and the rods would conduct that heat inside."

"If he wanted to create a breathable atmosphere in the cave—after devising an air lock for the entrance, of course—he'd have to seal the interior. That's where molten sulfur comes in."

Moon cement. We struggled back over the lava to where he had set up the Fresnel lens. The crack in the rock by now was piping hot. Green crumbled some sulfur into the crucible he had brought for the purpose, and placed it at the focal point of the lens. The sulfur began to smoke and melt.

"This stuff would be invaluable to a man on the moon," said Green as we watched it slump into fluid. "At varying viscosities, it has a wide range of uses. For instance, molten sulfur can be used for insulation, or as a liquid for separating minerals. It could also serve as a working fluid in a turbogenerator, or as a fluid to convey crushed rock to a furnace. It could become a lubricant."

Within 15 minutes, the hot orange fluid was ready to be poured into the crack in the rock. A half-hour after pouring, it had solidified.

"There," said Green. "That's a very dependable seal—against both gases and liquids. We've lab-tested similar ones."

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Exploring the "Moon" by Jeep

the aid of that Fresnel lens," I said.

"The source is all around you," Green declared. "Even run-of-the-mill volcanic rocks contain about one percent water. Some kinds—perlite and pitchstone, for instance—hold considerably more. A temperature of 400 degrees Centigrade will distill most of it out, and the solar furnace easily generates that. But the Fresnel lens is only part of the furnace. The rest is back in the lab."

The complete furnace, Green told me, consists of the lens, a vacuum chamber containing crushed volcanic rock, and a cold trap. The vacuum chamber imitates the moon's atmosphere, permitting steam to condense only at the cold trap.

"On the moon," he said, "any single-vented container that admitted sunlight would do for a boiler. And there'd be much greater solar energy available up there, too. Also, the lunar explorer wouldn't need a cold trap. He'd merely need to make sure that the vent tube of the boiler extended into shadow. There, vapor distilled from rocks would condense as ice, which he could quickly melt by bringing it into the sunlight."

Water from rocks. As we rode home, Green talked more about extracting water from rocks.

"It's pure," he said, "and its most important uses would be for drinking and cooking, naturally. But in an artificial, enclosed atmosphere, it could also be used to grow plants. Moon settlers could then feed the plants to fish and poultry raised for their tables."

"In large solar furnaces on the moon enough water might be boiled out of rocks to provide a practical source of both oxygen and hydrogen. Lunar explorers could use the oxygen to make breathable atmosphere. With the hydrogen, they might make rocket fuel to fire lunar samples to the earth or blast themselves back home."

I asked him if he knew of any plans for U. S. astronauts to try out equipment and exploring techniques in such places as the one where we had spent the day, before they head for the moon.

"No," he said somberly, "not yet. To me, it's a serious deficiency in these programs, a scientific paradox of the sixties. I hope it doesn't turn out to be the lament of the seventies."

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3 AUTO TRAILERS

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5 AVIATION

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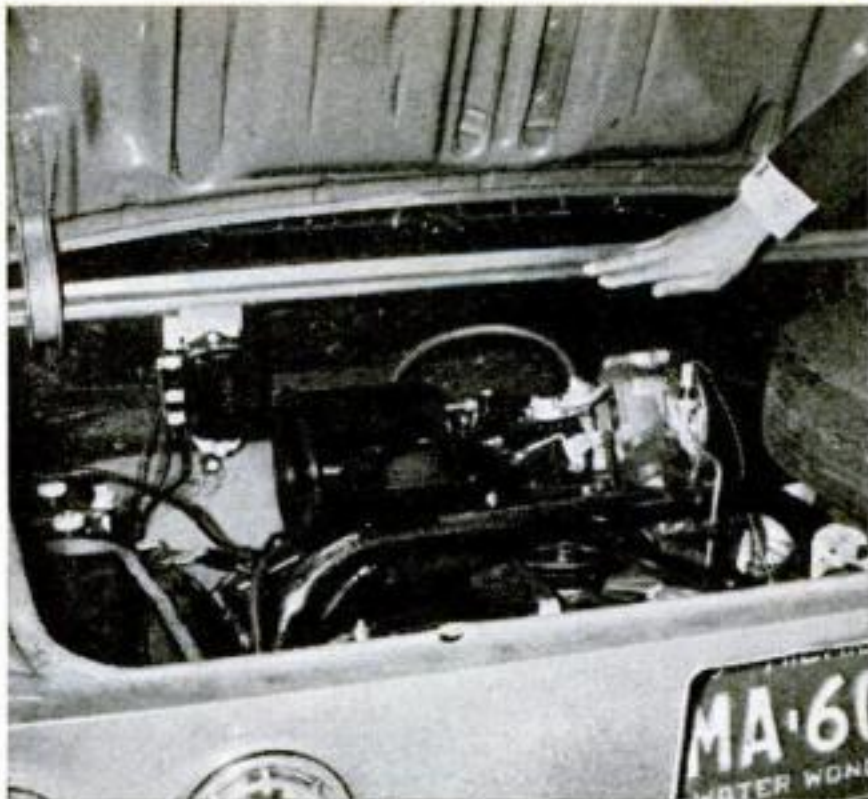
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6EPN-GYC-CTYR

150 Horses Hot

[Continued from page 80]



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cylinder-head pressures consistently bent the connecting rods, they beefed up the rods. When exhaust valves burned from the extra heat generated, they substituted valves made of Nimonic 80-A, one of the superalloys of chrome and cobalt on a

nickel base. The car demanded a heftier diaphragm spring on the clutch to take the torque. To accommodate the supercharging plumbing, a single air cleaner and carburetor had to be substituted for the two assigned to the twin cylinder banks on the standard Corvair. The carburetor lies on its side so the extra machinery can fit under the hood.

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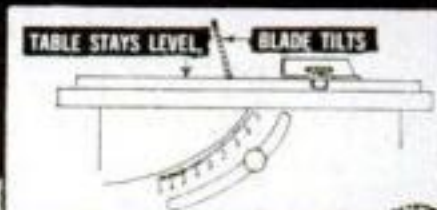
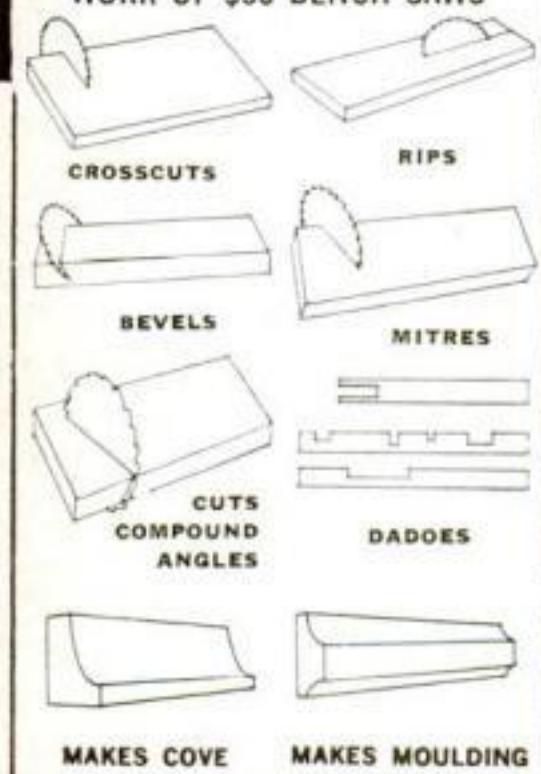
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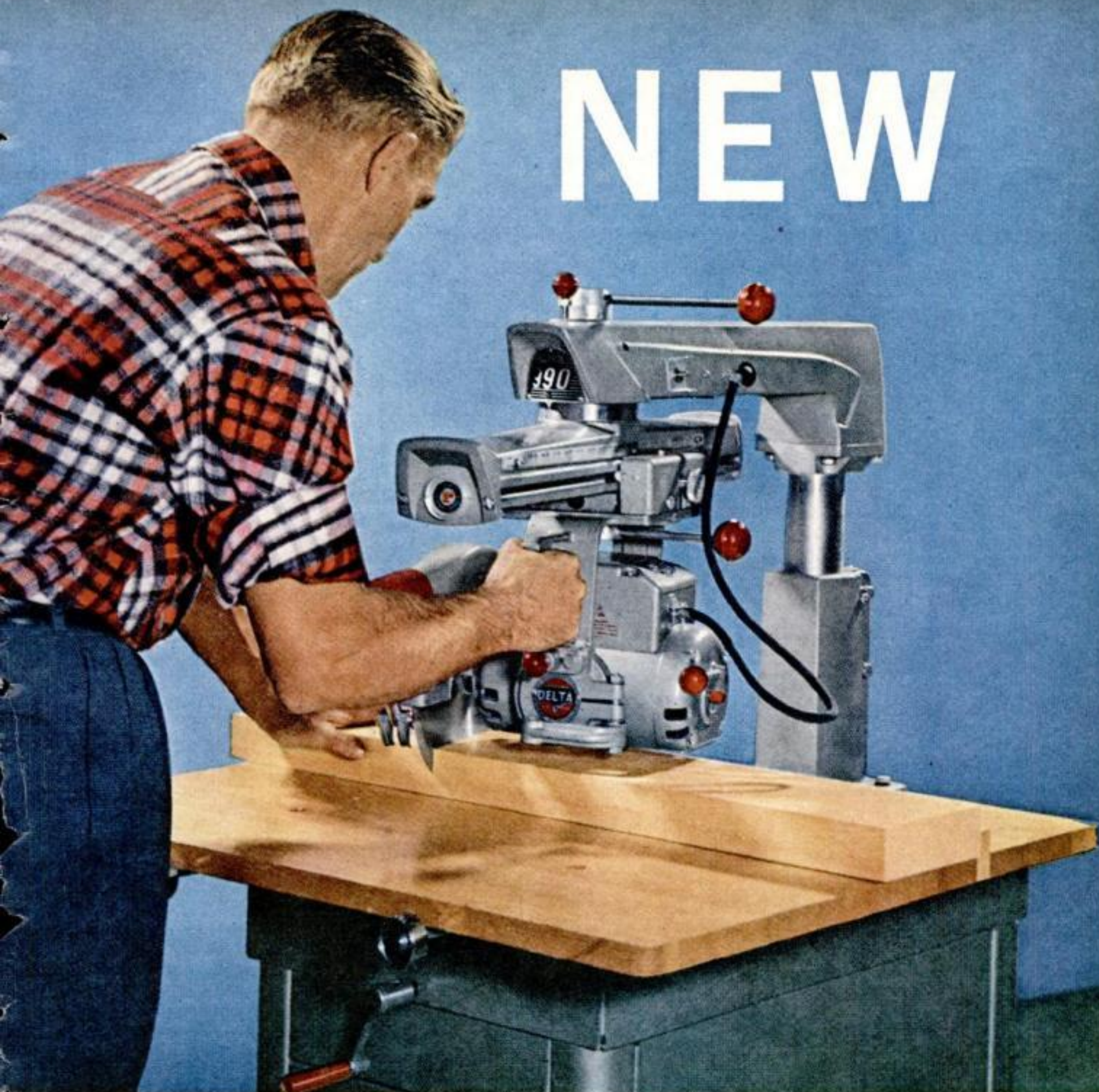
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